# FAUNA OF SAUDI ARABIA

VOL. 7 1985

Kingdom of Saudi Arabia
Meteorology and Environmental Protection Administration
Fauna Publication No. 7

*Editors:*

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Basle (Switzerland)

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Frankfurt (W. Germany)

XI. 86
Zürich

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## ADVISORY BOARD



ISBN 3-7234 0006 X


Printed in Switzerland by Arnold Fricker AG, Frick
Distributors: Pro Entomologia, Natural History Museum, Augustinergasse 2
CH-4001 Basle (Switzerland)
and
Karger Libri AG, Petersgraben 31, CH-4009 Basle (Switzerland)
(except Kingdom of Saudi Arabia)

Date of issue: 28 February 1986

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بسم الله الرحمن الرحيم

إِنَّا كُلَّ شَيْءٍ خَلَقْنَٰهُ بِقَدَرٍ

صدق الله العظيم

'Verily, all things have We created by measure'
From the Holy Quran, Sura 54, Verse 49.

# PREFACE

**Dr. Abdulbar Al-Gain**
Vice President, MEPA

This is the 7th volume of Fauna of Saudi Arabia. When the series was first started, a product of the selfless efforts of the many conservationists in Saudi Arabia and abroad, we hoped then that our combined efforts would be sustained over a long period of time.

I am pleased to state that this seminal activity is now recognized as the main information source for our work in the various aspects of animal conservation in the Kingdom.

The contributions on nature conservation in 'Fauna of Saudi Arabia' are timely, as they occur concurrently with the plans for the establishment of new marine and terrestrial protected areas in all regions of the Kingdom where special and often unique ecological, faunistic and floristic conditions prevail.

As a result of the first eleven years of the Zoological Survey conducted in the Kingdom, and the taxonomic and ecological investigations in the many different ecosystems of the country, much information on rare, endangered and endemic animals has been obtained. This provides the basis of the proposal for the planning and establishment of about 40 terrestrial nature reserves. These are situated in a large variety of land forms, ranging from hyper-arid sand seas, stony deserts, low to high altitude mountains, to marine coastal zones covering the numerous corresponding typical biotopes, accompanied by the characteristic assemblages of animal and plant life.

It must also be a source of immense pleasure for all of those who have contributed to this series and those concerned about conservation and environmental protection, to witness the growing interest in environmental protection by decision makers, the general public and the young generation in the Kingdom of Saudi Arabia.

It also gives us great satisfaction to note the continuous progress made in the Zoological Survey which significantly contributes to the regular publication of the 'Fauna'. The series now enjoys a growing interest on national, regional and international levels.

Dr. Abdulbar Al-Gain

# INTRODUCTION

It gives us great pleasure to report the successful continuation of the Zoological Survey in Saudi Arabia. As a result of the field work carried out in many areas of the Kingdom, and owing to specimens obtained from colleagues, it was possible once again to send representative collections to numerous specialists presently working at museums and universities.

According to the publication policy of Fauna of Saudi Arabia of including in the new volumes articles on environmental protection and animal conservation in Saudi Arabia, efforts were made to publish in this volume once again contributions on nature conservation management and animal ecology covering terrestrial, limnetic and marine biotopes.

We are most grateful to Sheikh Romaih M. Romaih, President, and Dr. Abdulbar Al-Gain, Vice President of MEPA for their continuous enthusiastic support of the "Fauna". We also owe an enormous debt of gratitude to Dr. M. Al-Deghaither and Mr. A. Dakkak, both of MEPA, Jeddah, for their constant administrative assistance. Sincere thanks are extended to Dr. I. Zeitoun, Director, NUS Corporation, Jeddah, for logistic support. Mrs. S. Büttiker, Jeddah, very ably assisted again in the field work and at home, and contributed, as usual, much to the progress made during the last year.

Dr. M. Brancucci and his staff at the Natural History Museum, Basel, have devoted much of their time to the processing of the material collected in Saudi Arabia, and their efforts are gratefully acknowledged. Special mention must be made to Dr. W. Schneider, Mainz, who helped in editing several manuscripts. Dr. D.J. Lewis, British Museum (Natural History), London, very kindly sorted again small Diptera and distributed them to several specialists for taxonomic work, in addition to his own investigation on the phlebotomine sandflies. We owe him and the numerous specialists of the British Museum (Natural History) our sincerest thanks for their meticulous work.

The editors regret the decision of Prof. Abdul Mon'im S. Talhouk to retire in late 1985 from his post with the Ministry of Agriculture and Water, Riyadh. Since 1977, he showed a lively interest in "Fauna of Saudi Arabia" and contributed important collections to the Zoological Survey, together with his team of university graduates, viz. Messrs R. Abu Zuhairah, A. A. Ajlan, K. Al Taher, A. A. Madi and S. B. Tilkian. The joint effort resulted in the establishment of the largest accurately identified insect collection in the Kingdom. The numerous groups sampled were mainly processed by Drs W. Wittmer and M. Brancucci and their staff at the Natural History Museum, Basel, and included in the taxonomic studies conducted by many specialists. The reference collection which is officially called "RAWRC" collection is now adequately housed at the Regional Agriculture and Water Research Center, Riyadh, and has been placed at the disposal of plant protection and quarantine personnel in the Ministry, and teachers in the agricultural colleges of the Kingdom. Prof. A. S. Talhouk started the survey by (1) using light traps in Riyadh, Hofuf, Qatif, Al Kharj, Qassim and Jizan; (2) rearing immature stages of insects on wild and cultivated plants and recording biological data for the different species; and (3) frequent field collecting trips in different regions of the Kingdom. These activities were carried out alongside the other duties of Prof. A.S. Talhouk which consisted mainly of the study of the biology of major agricultural pests in order to reduce their damage without seriously disturbing the ecosystems. In addition, an emphasis was placed on the rearing of juvenile insect stages to maturity in order to acquire knowledge of plant hosts and natural enemies of economic and non-economic phytophoga.

On the occasion of Prof. Talhouk's retirement, he wishes to acknowledge with gratitude the help received from Messrs R. Abu Zuhairah, A. A. Ajlan, K. Al Taher, A. A. Madi, and S. B. Tilkian as well as the support from the taxonomists, too many to be mentioned by name.

Owing to the continuing interest in the zoological research in the Kingdom shown by Dr. A. Bodmer, Chairman of the Executive Committee, Ciba-Geigy Ltd., Basle, an important financial contribution to Pro Entomologia was recently made by the company earmarked for "Fauna of Saudi Arabia". The generous donation is gratefully acknowledged.

The abstracts were translated into Arabic by Dr. Z. Amr, Amman, to whom the editors express their sincere thanks.

We are also grateful to numerous friends who have again supplied specimens and information on animals from Saudi Arabia, notably: Mr. Issa Al-Hartani, Jeddah; Mr. Khalid Amin, Jeddah; Mr. D. Bruce-Merrie, Jeddah; Dr. J. Burchard, Dhahran; Mr. & Mrs. A.C. Cleaver, Jeddah; Mr. P. Dickmann, Jeddah; Mrs. S. Collenette, Jeddah; Mr. & Mrs. J. Gasperetti, Jeddah; Dr. J. Grainger, Jeddah; Mr. K. Habibi, Sakakka; Dr. I. Ingemansson, Baha; Dr. R. Jones, Jeddah; Mr. W. Lüdin, Jeddah; Mr. E. Lüthi, Jeddah; Mr. P. Medley; Dr. I.A. Nader, Abha; Dr. A.K. Nasher, Abha; Dr. R. Prosser, Jeddah; Dr. J. Pujals, Baha; Mr. A. Stagg, Riyadh; Mr. D. Stevenson, Jeddah; and Mr. D. Vania, Jeddah.

Finally, we wish to thank the staff of the printing company, Arnold Fricker AG, notably Mr. H. Sennhauser, and Mr. G. Küng of Allprint AG, Zürich, for their enthusiastic collaboration in preparing the present volume.

Jeddah and Frankfurt, August 1985 The Editors

# Zoological Survey in Saudi Arabia 1983–1985

**W. Büttiker**

Abstract: Further to the previous reports on the zoological expeditions carried out in Saudi Arabia since 1975, this present account describes the field activities between mid 1983 and mid 1985. Information on a new sampling method introduced in the survey is given. A gazetteer of the main collecting sites is included in the report, and nine colour plates show some of the typical biotopes visited.

Keywords: Saudi Arabia, zoological survey, sampling methods, gazetteer, biotopes.

المسح الحيواني في المملكة العربية السعودية

١٩٨٣ – ١٩٨٥

و. بوتيكر

موجز : عطفا على التقارير السابقة حول الرحلات الاستكشافية الخاصة بالمسح الحيواني والتي توالت في المملكة العربية السعودية منذ عام ١٩٧٥ ، يبين هذا التقرير الانشطة الميدانية بين منتصف عام ١٩٨٣ ومنتصف عام ١٩٨٥ وقد تم ايراد معلومات في الدراسة عن طريقة جديدة لاخذ العينات ويشتمل التقرير على فهرس جغرافي للمواقع الاساسية لجمع العينات . وتبين تسعة الواح ملونة بعضا من الكنف النموذجية التي تمت دراستها .

" ... Unique land of Arabia, a naturalist's paradise, endless surprise for any anthropologist, a feast for the artist's eyes, and to me, the wayfarer, a source of much interest and delight."

Bertram Thomas, 1927

## INTRODUCTION

Two years have passed since the publication of the last account of activities pertaining to the zoological survey in the Kingdom of Saudi Arabia (Büttiker 1983). Numerous short collecting trips and several expeditions by the author, sometimes accompanied by MEPA staff and other specialists, yielded several thousand specimens of molluscs, arthopods, amphibians, reptiles, fishes, mammals and other animals, all of which were processed for study by experts of certain groups. There are, however, still a few families and other groups for which no experts are presently available. For the time being, this scientific material is being stored at the Natural History Museum, Basle. In addition, several collections of small Diptera, e.g., phlebotomine sandflies, Chironomidae, Cecidomyidae, have been sent directly to the British Museum (Nat. Hist.), London for processing and identification.

Descriptions of the new collecting sites and of the locations revisited once or on several occasions are listed in the gazetteer. It is felt that the information given may help the specialists to correlate their results with faunistic, ecological and zoogeographical parameters. The author would be delighted to give additional information on the ecosystem of these sampling sites upon request.

Live specimens of ticks have again been sent to Dr. H. Hoogstraal, NAMRU-3, Cairo, for isolation of disease agents; live scorpions to Mr. M. E. Braunwalder, Zürich, for rearing and biological studies; and live Tenebrionidae to Dr. R. D. Stevenson, Max-Planck-Institute, Andechs (F. R. G.), for biological and ethological studies.

It gives me great pleasure to mention that additional experts have started taxonomic and faunistic studies based on material available but so far not included in previous publications, e.g., Myriapoda, Crustacea, Solifuga and other families of spiders, Syrphidae.

## SAMPLING METHODS

In addition to the methods used in previous years, the flea sampling in rodent and reptile burrows was conducted according to the method used by Dr. A. Barnes, Fort Collins, USA, and yielded excellent results (fig. 1). The gadget consists of a flexible rod with a hand-operated finger clip to which a piece of flanelette is attached. The far end is introduced into the openings of the animal burrows, retrieved and the cloth placed in a plastic bag. The fleas are then separated and placed into vials containing 70% methanol.

Fig. 1: Flea sampling method according to Dr. A. Barnes in small animal burrows.

## COLLECTING SITES

During the two years under review, numerous short field trips and five larger expeditions were carried out. A gazetteer in alphabetical order comprises all these main collecting sites (tab. 1) and should be regarded as a continuation of the previous compilations (Büttiker 1979, 1980a & b, 1981, 1983; Büttiker & Wittmer, 1979; Abo-Khatwa et al., 1980; Lewis & Büttiker, 1982: 394–397; and Crosskey & Büttiker, 1982: 408).

The main collecting sites visited in Saudi Arabia have also been plotted in a sketch map (fig. 1) which reflects the sampling activity between 1975 and 1985.

More detailed maps (figs 2–5) indicate the collecting sites of the larger expeditions carried out in the western, southwestern and northwestern regions of the Kingdom. Some of the typical biotopes visited in the course of the field trips are shown on the colour plates (plates 1–9).

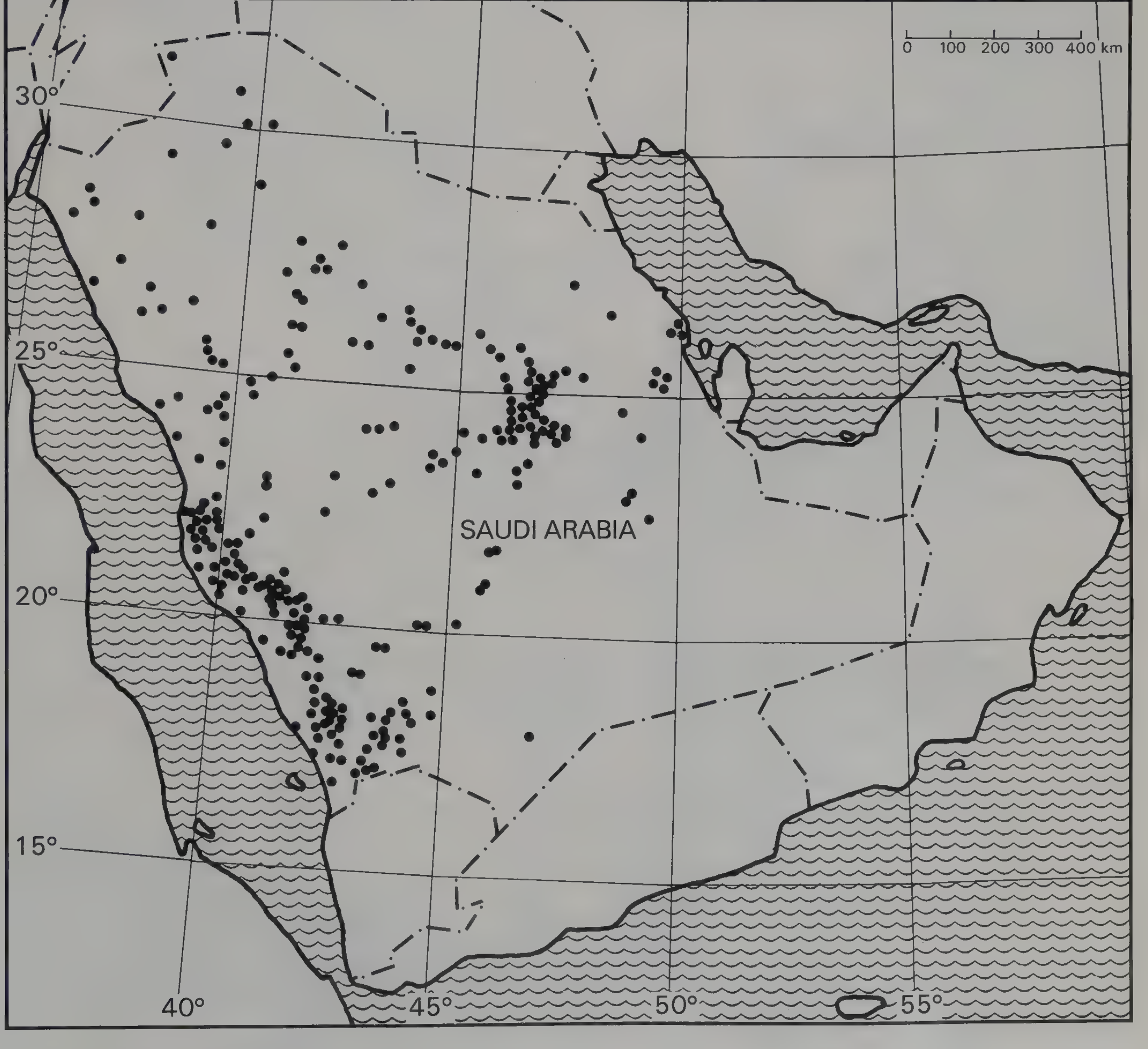


Fig. 2: Map showing the main collecting sites of the zoological survey carried out by the author between 1975 and 1985.

## ACKNOWLEDGEMENTS

Sincerest thanks are due to Dr. A. Al-Gain, Dr. M. Al-Deghaither, Mr. A. Dakkak and Mr. H. Al-Ghamdi for their constant support in conducting the field survey in the framework of the author's activities with MEPA.

I am grateful to many colleagues and friends who have collected and donated specimens from various regions of Saudi Arabia. Their collaboration has been gratefully acknowledged in the introduction of this volume. However, special mention has to be made to my dear wife, Sonya, who again accompanied me on all expeditions, both short and long, during the last two years reviewed in this article.


Fig. 3: Map showing the main collecting sites of the Asir Expedition, September 1983. The geographic data are given in the gazetteer.


Fig. 4: Map showing the main collecting sites of the Asir Expedition, August/September 1984. The geographic data are mentioned in the gazetteer.

**Table 1: Gazetteer of the new main collecting stations, Zoological Survey of Saudi Arabia, 1983–1985**

| Location | Adm. Division | Altitude (m) | Latitude N | Longitude E |
|---|---|---|---|---|
| Amer, Wadi | Asir | 2400 | 18°52′ | 42°16′ |
| An, Jebel | Makkah | 1240 | 21°19′ | 41°10′ |
| Aqabat al Khuraytah | Tabuk | 1120 | 27°48′ | 36°04′ |
| Aqdah, Al | Hail | 1090 | 27°33′ | 41°36′ |
| Aridah, Wadi | Baha | 1480 | 20°25′ | 41°12′ |
| Aziza, Wadi | Asir | 2410 | 18°13′ | 42°28′ |
| Bagaigah, Wadi | Medina | 1120 | 22°52′ | 39°52′ |
| Bani Kebir | Baha | 2090 | 20°00′ | 41°35′ |
| Bani Rizam | Asir | 2230 | 18°07′ | 42°27′ |
| Bani Sar | Baha | 2180 | 20°13′ | 41°27′ |
| Baqarah, Wadi | Asir | 450 | 18°45′ | 41°59′ |

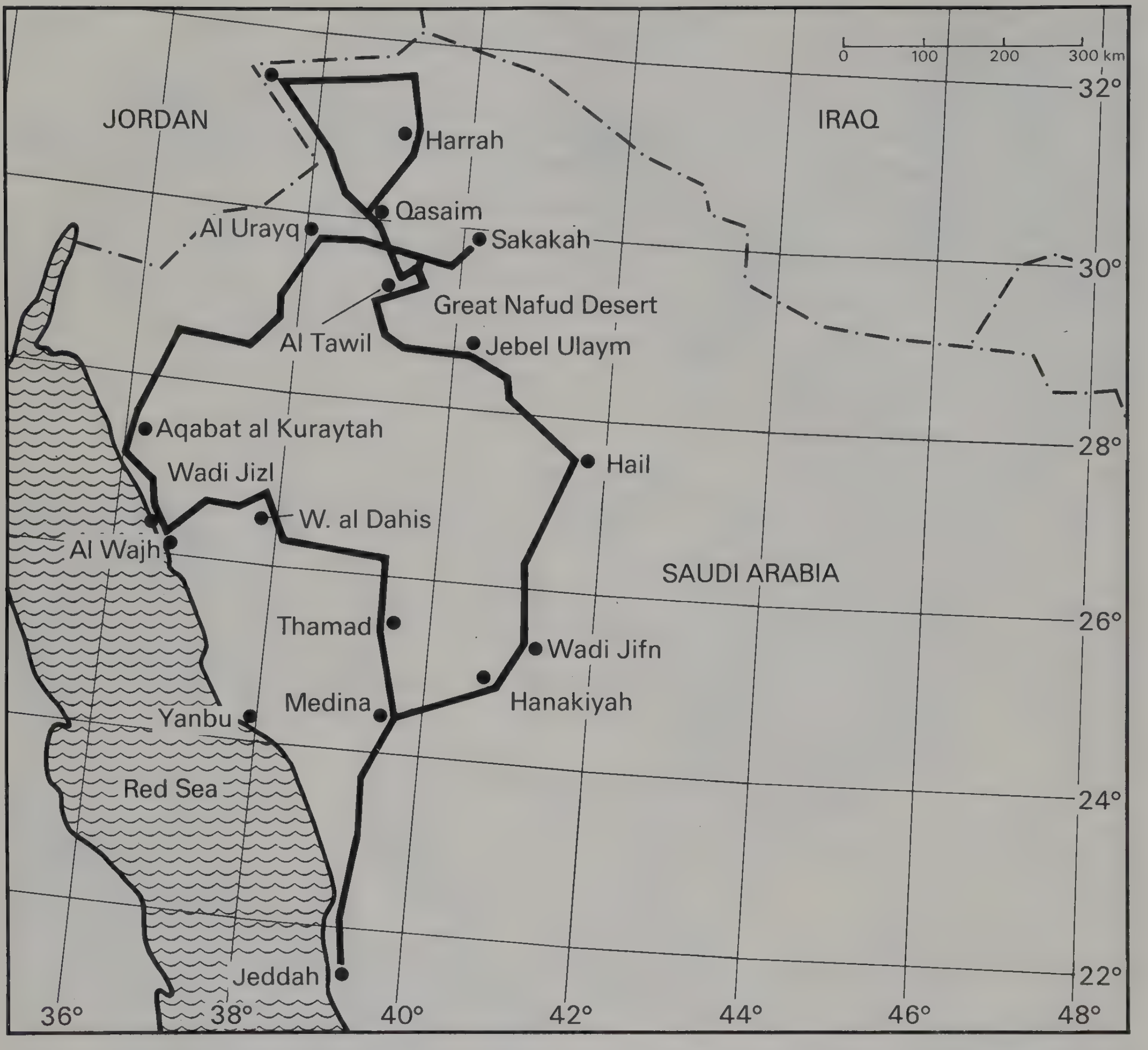


Fig. 5: Map showing the main collecting sites of the Hedjaz Great Nafud Expedition, November 1984. The geographic data are given in the gazetteer.

| Location | Adm. Division | Altitude (m) | Latitude N | Longitude E |
|---|---|---|---|---|
| Bedouin Camp (Nafud) | Hail | 900 | 28°24′ | 40°43′ |
| Beles, Jebel | Baha | 2070 | 19°48′ | 41°51′ |
| Buwah, Wadi | Makkah | 1320 | 20°19′ | 41°14′ |
| Dahis, Wadi al | Medina | 689 | 26°30′ | 37°58′ |
| Dhablah, Jabal | Hail | 950 | 27°44′ | 41°18′ |
| Dhibinat | Northern Frontier | 450 | 31°28′ | 38°14′ |
| Dhiyan, Wadi (1) | Baha | 1050 | 19°50′ | 41°28′ |
| Dhiyan, Wadi (2) | Baha | 830 | 19°48′ | 41°36′ |
| Ellah, Wadi | Makkah | 1480 | 20°35′ | 41°15′ |
| Fare | Makkah | 850 | 22°45′ | 39°47′ |
| Fatimah, Wadi | Makkah | 200 | 21°15′ | 39°49′ |
| Fayidah, Wadi | Makkah | 130 | 21°52′ | 39°30′ |
| Foqah (1) | Baha | 1570 | 19°49′ | 41°52′ |
| Foqah (2) | Baha | 1630 | 19°50′ | 41°51′ |

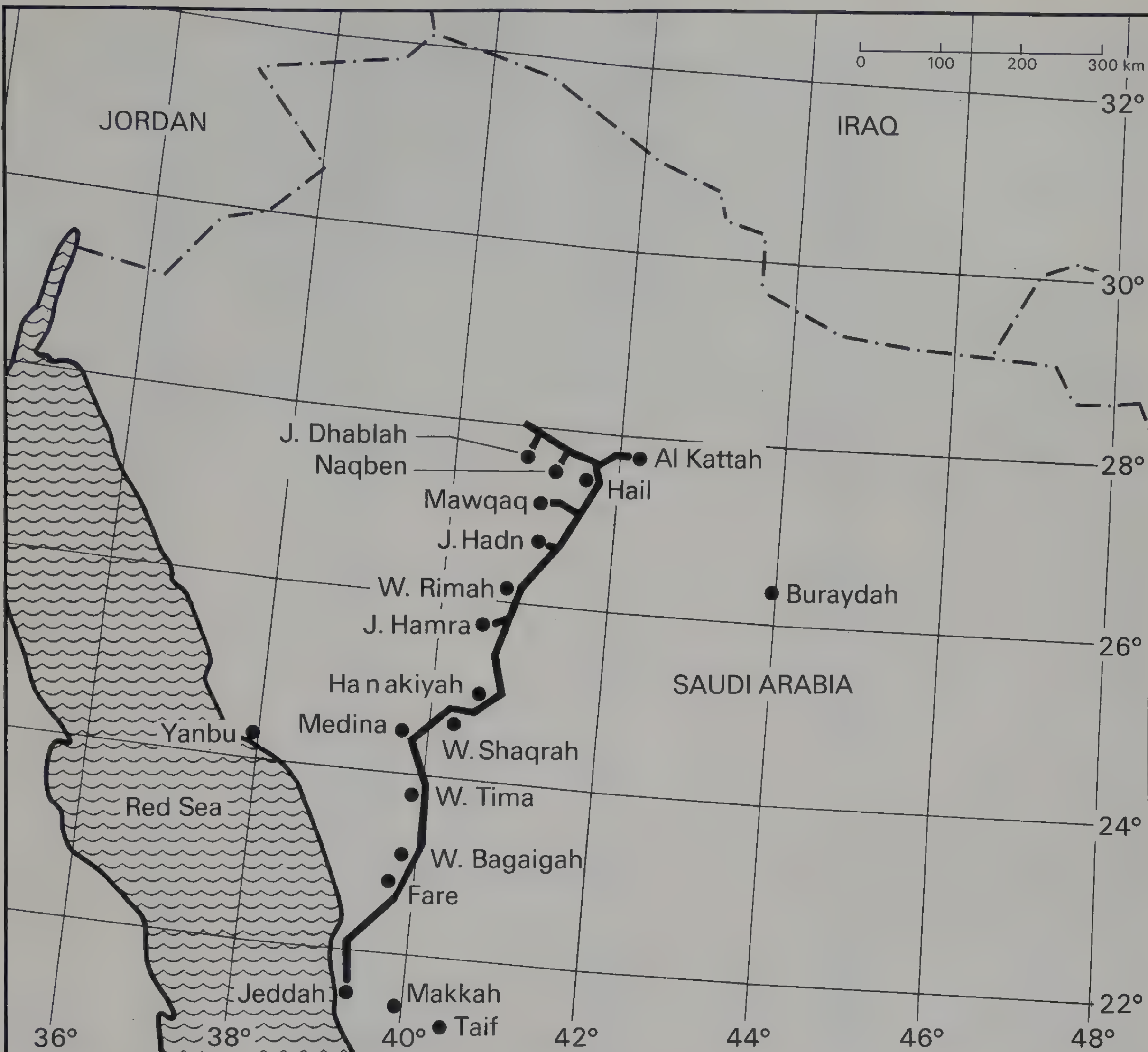


Fig. 6: Map showing the main collecting sites of the Jabal Shammar Expedition, April/May 1985.

| Location | Adm. Division | Altitude (m) | Latitude N | Longitude E |
|---|---|---|---|---|
| Ghamdiyah, Jebel Al | Makkah | 60 | 20°48′ | 39°48′ |
| Ghat, Wadi | Asir | 450 | 19°06′ | 41°55′ |
| Hadad, Wadi | Makkah | 1600 | 20°41′ | 40°59′ |
| Hadn, Jabal | Hail | 1080 | 26°57′ | 41°10′ |
| Hail | Hail | 979 | 27°35′ | 41°42′ |
| Hamra, Jabal | Medina | 1000 | 25°37′ | 40°41′ |
| Hanakiyah, Wadi | Medina | 850 | 24°51′ | 40°30′ |
| Hanakiyah | Medina | 850 | 24°47′ | 40°24′ |
| Hanaq, Wadi (Camp 2) | Makkah | 100 | 22°44′ | 39°15′ |
| Harithi (1) | Makkah | 1910 | 21°18′ | 40°18′ |
| Harithi (2) | Makkah | 1950 | 21°19′ | 40°19′ |
| Harrah | Jawf | 700 | 31°01′ | 38°42′ |
| Harran, Wadi | Makkah | 220 | 22°00′ | 39°34′ |
| Ibrahim, Jebel | Baha | 1540 | 20°25′ | 41°11′ |

| Location | Adm. Division | Altitude (m) | Latitude N | Longitude E |
|---|---|---|---|---|
| Ilyab, Wadi | Baha | 160 | 20°07′ | 40°57′ |
| Jifn, Wadi | Hail | 870 | 25°47′ | 41°27′ |
| Jizl, Wadi | Medina | 1000 | 26°42′ | 37°15′ |
| Juranah, Wadi | Makkah | 400 | 21°04′ | 39°56′ |
| Kaf | Qurayyat | 400 | 31°23′ | 37°30′ |
| Kattah, Al | Hail | 900 | 27°50′ | 42°04′ |
| Khashm, Al | Makkah | 630 | 24°07′ | 46°19′ |
| Khor Aniq | Makkah | 0 | 18°29′ | 41°26′ |
| Khaur Al Jaafirah | Gizan | 0 | 17°12′ | 42°21′ |
| Lebabah, Jebel | Gizan | 120 | 18°15′ | 41°45′ |
| Majarish, Wadi (1) | Makkah | 700 | 21°19′ | 40°13′ |
| Majarish, Wadi (2) | Makkah | 1020 | 21°25′ | 40°12′ |
| Maraum, Wadi | Makkah | 280 | 22°16′ | 39°14′ |
| Mawqaq | Hail | 1190 | 27°19′ | 41°11′ |
| Medina (E of town) | Medina | 650 | 24°32′ | 39°33′ |
| Mibhil | Qassim | 800 | 25°20′ | 43°17′ |
| Mirtad, Wadi | Makkah | 1500 | 20°53′ | 40°53′ |
| Naamah (1) | Baha | 2100 | 20°15′ | 41°16′ |
| Namaah (2) | Baha | 2010 | 20°40′ | 41°13′ |
| Naqben | Hail | 1050 | 27°41′ | 41°38′ |
| Qust, Wadi | Makkah | 1400 | 20°56′ | 41°06′ |
| Oreste | Gizan | 0 | 16°23′ | 42°46′ |
| Qaba | Medina | 640 | 24°27′ | 39°13′ |
| Qasaim | Jawf | 750 | 30°15′ | 38°42′ |
| Rahifa | Asir | 2320 | 18°01′ | 42°46′ |
| Ras Hatibah | Makkah | 1 | 21°56′ | 39°01′ |
| Rimah, Wadi ar | Qasim | 1000 | 26°06′ | 40°51′ |
| Sakakah | Jawf | 760 | 29°58′ | 40°11′ |
| Sawarmah (1) | Makkah | 0 | 18°00′ | 41°40′ |
| Sawarmah (2) | Gizan | 0 | 16°40′ | 42°44′ |
| Shaqrah, Wadi (1) | Medina | 840 | 24°40′ | 40°18′ |
| Shaqrah, Wadi (2) | Medina | 845 | 24°42′ | 40°17′ |
| Sharm Wasm (South) | Makkah | 0 | 18°00′ | 41°40′ |
| Shib Abu Liqua | Gizan | 0 | 17°27′ | 42°17′ |
| Shib Al Kabir | Gizan | 0 | 17°20′ | 42°19′ |
| Shuqub, Wadi (1) | Makkah | 1310 | 20°43′ | 41°10′ |
| Shuqub, Wadi (2) | Makkah | 1380 | 20°44′ | 41°09′ |
| Suda, Jebel (1) | Asir | 2450 | 18°14′ | 42°28′ |
| Suda, Jebel (2) | Asir | 2550 | 18°15′ | 42°27′ |
| Sudr, Wadi | Asir | 1130 | 18°00′ | 42°37′ |
| Tanomah | Asir | 2150 | 18°54′ | 42°12′ |
| Tawil, Al | Jawf | 840 | 29°16′ | 39°34′ |
| Tayyah, Wadi | Asir | 950 | 18°32′ | 42°14′ |
| Thamad | Medina | 670 | 25°42′ | 39°17′ |
| Tima, Wadi | Medina | 1000 | 23°44′ | 39°47′ |
| Ulaym, Jebel | Jawf | 830 | 28°42′ | 40°27′ |
| Uqdah, Al (several sites) | Makkah | 1700–1950 | 21°03′ | 40°00′ |
| Urayq, Al | Northern Frontier | 710 | 29°54′ | 38°17′ |
| Wajh, Al | Tabuk | 0 | 26°21′ | 36°23′ |
| Wasm, Al | Makkah | 0 | 18°00′ | 41°38′ |

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Prof. W. Büttiker, Lanzenberg 21, 4312 Magden, Switzerland.

Plate 1: Jebel Ibrahim (elev. 2595 m at top) in the Asir mountains (Baha Province), a granitic dome with rich, fairly undisturbed vegetation and still varied animal life.

Plate 2: Jebel Beles (elev. 2070 m) near Al Foqah in the Asir mountains of the Baha Province. Rich natural vegetation with associated animal life due to presence of well established protected areas, the traditional hema systems.

Plate 3: Collecting site at Harithi (elev. 1950 m) near Taif (Makkah Province) in the Asir mountains. Fairly undisturbed vegetation and associated wildlife in a large traditional hema.

Plate 4: Wadi Ilyab (elev. 160 m) in the Asir Tihama. Note the rich riverine and aquatic vegetation.

Plate 5: Wadi Maraum (elev. 280 m) in the Hedjaz foothills, 80 km north of Jeddah with a permanent river and profous riverine and aquatic vegetation and associated animal life.

Plate 6: Typical desert biotope at Mibhil (elev. 800 m) in the Qassim Province situated in central Saudi Arabia. Predominant plant species are halophytic Chenopodiaceae.

Plate 7: Wadi Jizl (elev. 1000 m) in the central Hedjaz mountains (Medina Province) showing the typical vegetation cover.

Plate 8: Harrat al Harrah (elev. 900 m) in the Jawf Province with sparse plant growth between the basaltic lava boulders.

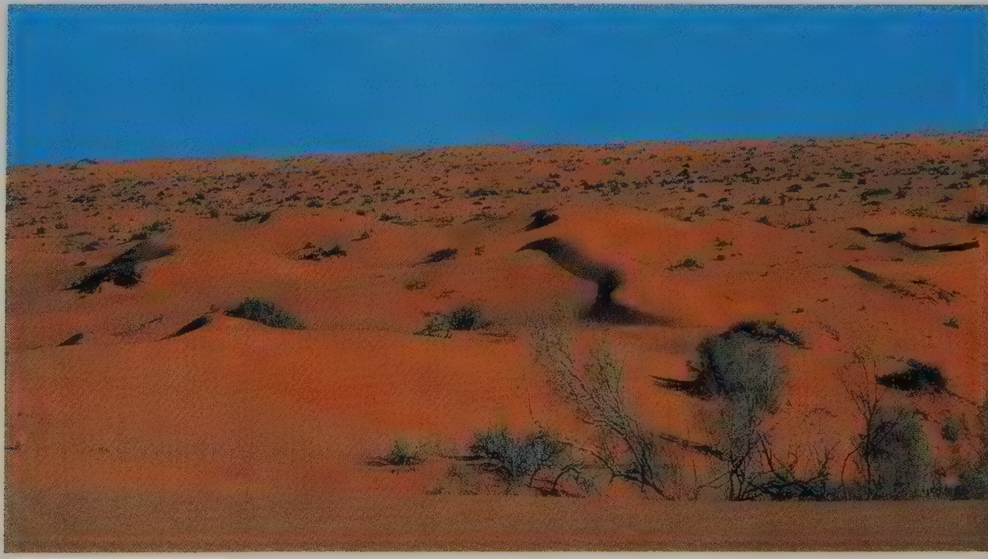

Plate 9: Collecting site in the Great Nafud desert near Jebel Ulaym (elev. 830 m) in the Hail Province. *Haloxylon persicum* is the main large plant representative.

# Reefs and Coral Assemblages of Saudi Arabia 1. The Central Red Sea at Yanbu al Sinaiyah

**C. R. C. Sheppard, A. L. S. Sheppard**

Abstract: The reefs of Yanbu al Sinaiyah, Saudi Arabia consist of: (1) a fringing reef, (2) a series of circular and elongated patch reefs closely adjacent to the fringing reef and separated from it by water of 5–10 m deep, (3) scattered patch reefs at least 1 km offshore and separated by water of at least 30 m deep, (4) patch and ribbon reefs forming a barrier reef complex located on a platform several km offshore. Coral assemblages (116 species and species groups) were recorded at 101 sites from the full range of reef habitats. Cluster analysis using the Bray Curtis measure distinguished 13 coral assemblages: 4 from exposed conditions dominated by *Acropora;* 3 from sheltered conditions dominated by *Porites;* and the remainder characterised by other genera, or characterised by a high diversity with no dominant corals. The most distinctive coral zones are shallow water *Acropora* zones on the outer reefs; these equate with zones found in much more exposed conditions elsewhere in the Indo-Pacific. Diversity is greatest between 10–20 m deep on seaward slopes, and at 5 m deep on back reef slopes, while coral cover has a peak at 1–3 m deep on all reef slopes. In sedimented areas, cover and diversity are very low and there are no diagnostic species. Both the coral diversity and the number of different coral assemblages which they form are greater than have been recorded for the Red Sea to date.

Keywords: Reefs, corals, central Red Sea, zoogeography.

تجمعات الشعب المرجانية في المملكة العربية السعودية

١. وسط البحر الاحمر (ينبع الصينايع)

سي . ر. سي شيبارد و ا. ل . س . شيبارد

خلاصة : تتألف شعاب ينبع الصينايع في المملكة العربية السعودية من التالية :
١- شعاب هدابية . ٢- مجموعة من الشعاب المستديرة والمستطيلة قريبة من الشعاب الهدابية وتنفصل عنها بماء عمقها ٥-١٠ أمتار . ٣- مجموعة شعاب متناثرة تبعد ١ كيلومتر عن الساحل ومنفصلة عن الشعاب الأخرى على عمق ٣٠ متر. ٤- مجموعة من الشعاب الشريطية مكونة حاجزا شعابي تقع على القعر وعلى بعد عدة كيلومترات من الساحل . ولقد تم تسجيل ١١٦ نوعا ومجموعات انواع من التجمعات المرجانية من ١٠١ موقعا من مواطن الشعاب . وأظهرت نتائج التحليل الجماعي باستخدام مقياس Bray Curtis ١٣ نموذجا من التجمعات المرجانية : ٤ منها يسود فيها النوع Acropora في مناطق معرضة ، ٣ منها من مناطق مخفية يسود فيها النوع Porites ، والتجمعات الباقية مميزة بأجناس آخرى أو مميزة بتنوع كثير ولكن بدون وجود نوع سائد من المرجان . أن شعاب الـ Acropora التى تنمو في المياه الضحلة هي من المناطق المميزة ، حيث تشابه بعض المناطق المعرضة في المحيط الهندي والهادي . وتصل ذروة التنوع على أعماق تتراوح ما بين ١٠- ٢٠ مترا من منحدرات البحر الجانبية و ٥ أمتار من المنحدرات التي تقع الى الخلف من الشعب ، بينما يصل الحد الاعلى للغطاء المرجاني على عمق يتراوح ما بين متر الى ٣ أمتار من منحدرات الشعاب . وفي المناطق الرسوبية ، فان التنوع والغطاء المرجاني يكون قليلا جدا ولا يوجد أنواع سائدة . ويمثل هذا البحث اشمل دراسة تتعلق بأنواع المرجان وانواع التجمعات المرجانية الموجودة في البحر الأحمر حتى هذا الوقت .

## INTRODUCTION

Nearly 2,000 kilometres of Red Sea coastline, or about 80% of its northern shore, lies within Saudi Arabia. In recent years, there have been three main organisations which have carried out research on the coral reefs of the Red Sea coast of the Kingdom. One is the King Abdul Aziz University in Jeddah, whose work is outlined by BEHAIRY (1982). The second is research carried out by a team from the International Union for Conservation of Nature and Natural Resources (IUCN) and the Tropical Marine Research Unit (TMRU) of the University of York for the Meteorology and Environmental Protection Administration (MEPA). These consist of broad scale surveys along the Red Sea coast. The third organisation through which work has been conducted is the Royal Commission for Jubail and Yanbu, and a study carried out at the Royal Commission city of Yanbu al Sinaiyah is the subject of the present account.

A detailed history of coral reef studies in the Red Sea is given by MERGNER (1984). Most ecological accounts of Red Sea coral reefs have concerned the fringing reef in the Gulf of Aqaba (LOYA & SLOBODKIN 1971; LOYA 1972; MERGNER & SCHUHMACHER 1974, 1981; BENAYAHU & LOYA 1977; MERGNER 1979). In the main body of the Red Sea, however, coral reefs appear to be more complex and diverse (VINE & VINE 1980). The best known of these are off Port Sudan, and these have been examined from standpoints including ecology (HEAD 1980; MERGNER 1971), geomorphology (BRAITHWAITE 1982), and various biological and ethological aspects (see HEAD & ORMOND 1978; BEMERT & ORMOND 1981). However, as pointed out by BEHAIRY (1982) work on coral reef ecology in the main body of the Red Sea is very limited.

The structure of the reefs off Yanbu al Sinaiyah appear to be amongst the most complex known from the Red Sea. A classical fringing reef is present, to seaward of which lies two series of patch reefs. Further offshore, beyond a deep channel, there is a further series of reefs based on a broad platform. This outer series resembles a small, discontinuous barrier reef. The corals and coral reefs from a region of this morphological complexity have not been described from any part of the Red Sea to date. The following therefore (1) describes the morphology of these reefs, before (2) analysing the coral assemblages in this central Red Sea location. Finally, we compare the range of coral assemblages found in this site to those which occur elsewhere in the Red Sea and Indo-Pacific.

## METHODS AND THE SURVEY AREA

Figs 1 and 2 show the survey area. The first is a general map which includes the locations of all known reefs in the area which reach the surface, and includes bathymetric contours and the tracks of two echosounder profiles which were taken across the area. Fig. 2 shows the reefs which were sampled.

We examined the fore- and back reef slopes of 12 offshore reefs and also of eight locations on the fringing reef, using a combination of echosounder and underwater measurements with tape and depth gauge. It was found that the reefs fell into 4 main groups for descriptive purposes (described later). Then, from 28 reef slopes (marked by letters in fig. 2), and from a reef slope north of Yanbu, a total of 101 sites were selected for examination, each site being based on or bounded by clear topographical entities or features where these existed, or by pre-defined depth intervals. Appendix 1 gives details of each of the 101 sites, including their depth spans and slopes. Typically, the topographical features by which site selection was made included the reef crest or sharp changes in substrate slope. The dominant corals, or coral zones, were never used to demarcate a site. The total 101 sites thus included several examples of each combination of reef type, fore- or back reef position, and depth range.

From each site (fig. 2), coral species were recorded from an area of at least 500 m², together with the percent cover of all species which appeared to cover more than 2% of the substrate. Where possible, these areas were squares of side 22 m, but where the selected topographical feature was narrow (e.g. the reef crest) the observed area traversed a much wider but narrower band across the reef. From a total

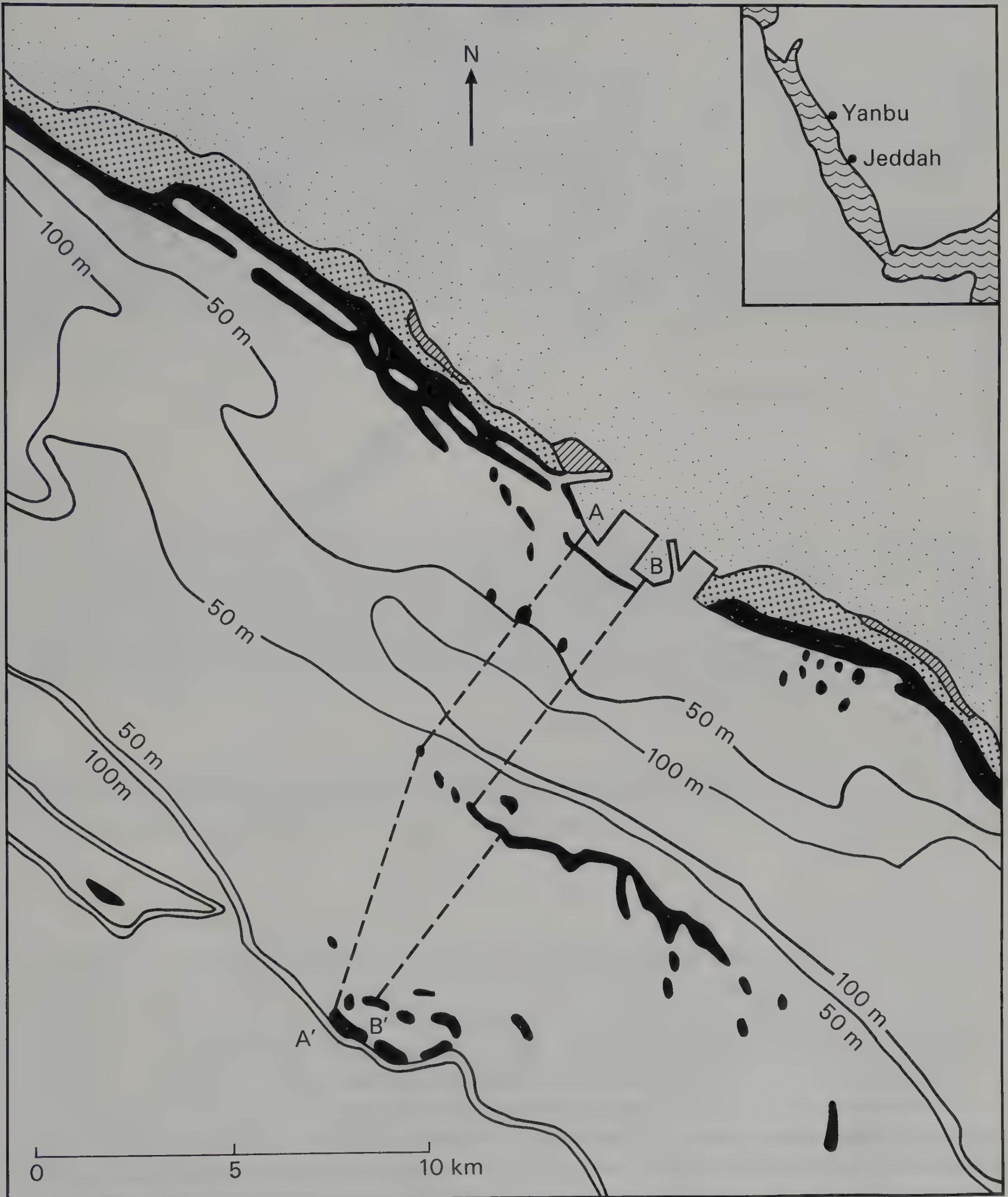


Fig. 1: Study site at Yanbu, Saudi Arabia. Surface-reaching reefs are shown in black, mud flats are dotted, mangroves are hatched. Depth contours of –50 m and –100 m are shown. Broken lines A'A and B'B are echosounder tracks (see fig. 6).

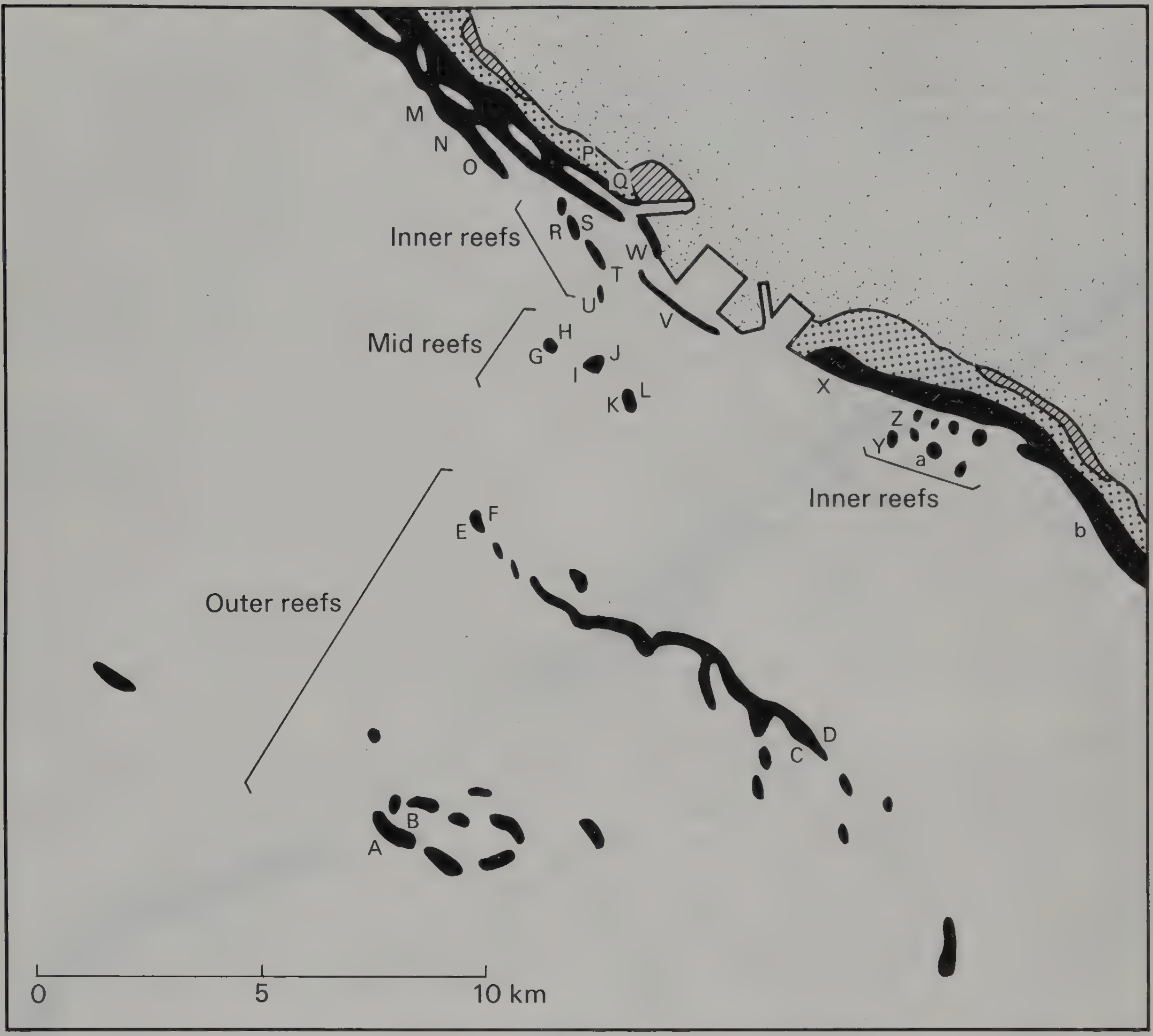


Fig. 2: The study site showing the position of all coral reefs examined in the survey. A–F are outer reefs, located on the offshore platform shown in fig. 1. G–L are mid reef sites. R–V and Y, Z and a are inner reefs. M–Q, W, X and b are areas of the fringing reef which were examined.

of 150 coral species identified within the laboratory, 116 species or species groups were reliably identifiable underwater and these formed the basis of the analysis presented here. Appendix 2 lists the species. That only 116 species and species groups were used is due to the indistinguishable nature of several species underwater, notably those in the genera *Acropora, Montipora, Porites* and *Alveopora.* Visual estimates were also made for cover by coral, soft coral, calcareous algae and sand.

The matrix of 116 species × 101 sites was subjected to cluster analysis. The quantitative Bray-Curtis (1957) similarity coefficient was used, followed by a hierarchical clustering of sites and groups of sites (Sneath & Sokal 1973; Van den Hoek et al. 1975). In this method, two sites or clusters, once matched, were replaced by their centroid, determined as the arithmetic mean of the similarity coefficients.

Details of wave energy and winds were obtained for the area concurrently (EESAL 1983) or a few years previously (Tetra Tech 1980; Georeda 1982). These data are given in the results.

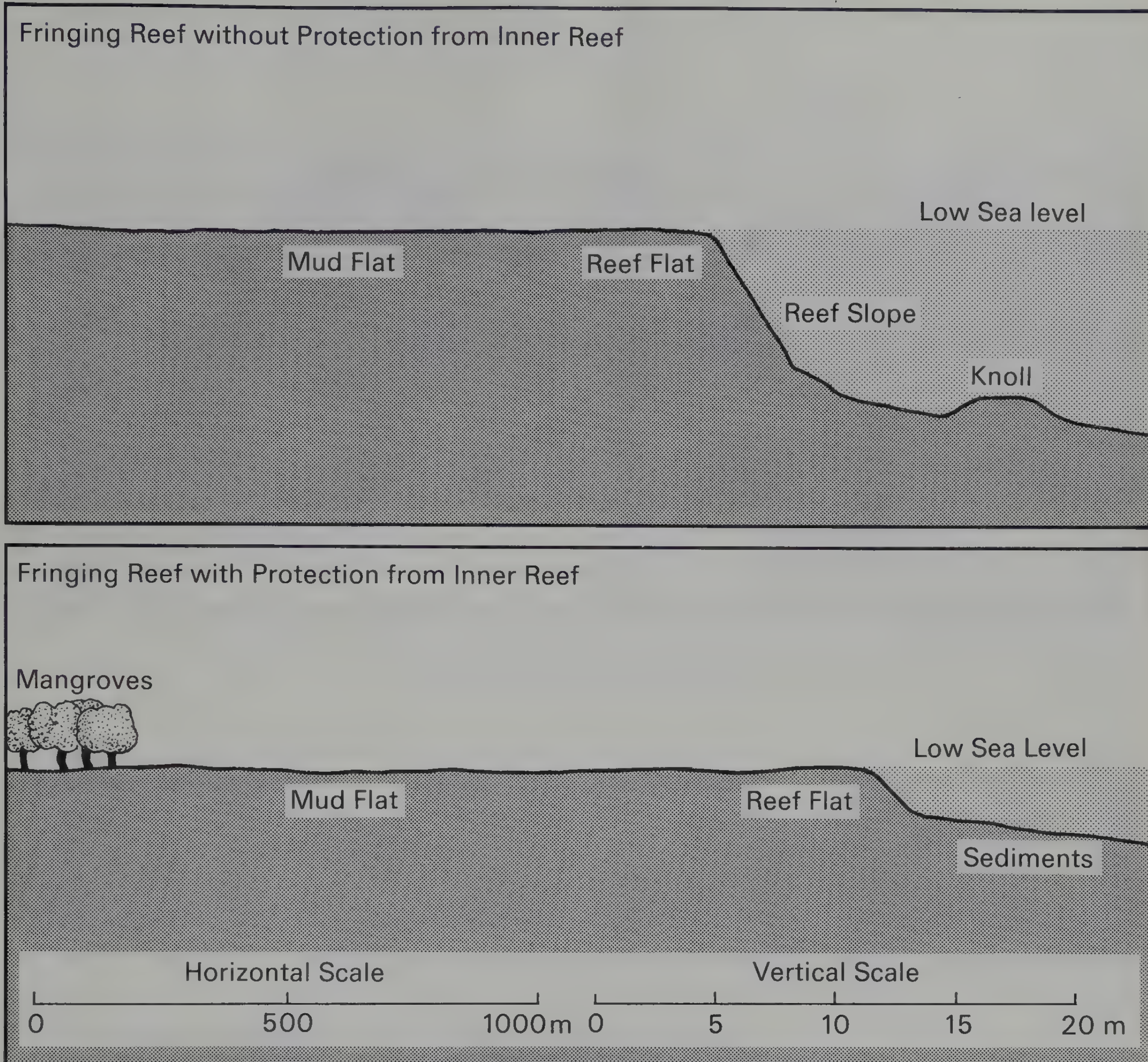


Fig. 3: Typical profiles of fringing reefs: top, without protection from inner reefs, bottom, with protection from inner reefs.

## The survey area

Within the survey area four basic types of reefs were evident (fig. 2).

(1) Fringing reefs. In the area of Madinat Yanbu al Sinaiyah, the reef flats are generally broad, extending outwards for up to 1 km from the shore. The shoreward parts of these are covered in a layer of mud up to 1 m thick and, where the reef flats are more sheltered, the mangrove *Avicennia marina* forms thick stands. Fig. 3 shows the two typical profiles of the fringing reef of the area. In the first type, there is a fairly steep reef slope at the edge of the reef flat to about 10 m deep; in such cases mangroves rarely occurred on the reef flats. Sites M, N, O, X and b are examples (fig. 2). In the second type the reef flats are more sheltered and lie behind patch reefs offshore; in these cases the slope is very short and gives way to sediments at 2–5 m deep and mangroves were usually found on the reef flat (e.g. sites P, Q, and W in fig. 2). In both types of fringing reef, water turbidity was always higher than on all the other kinds of reef.

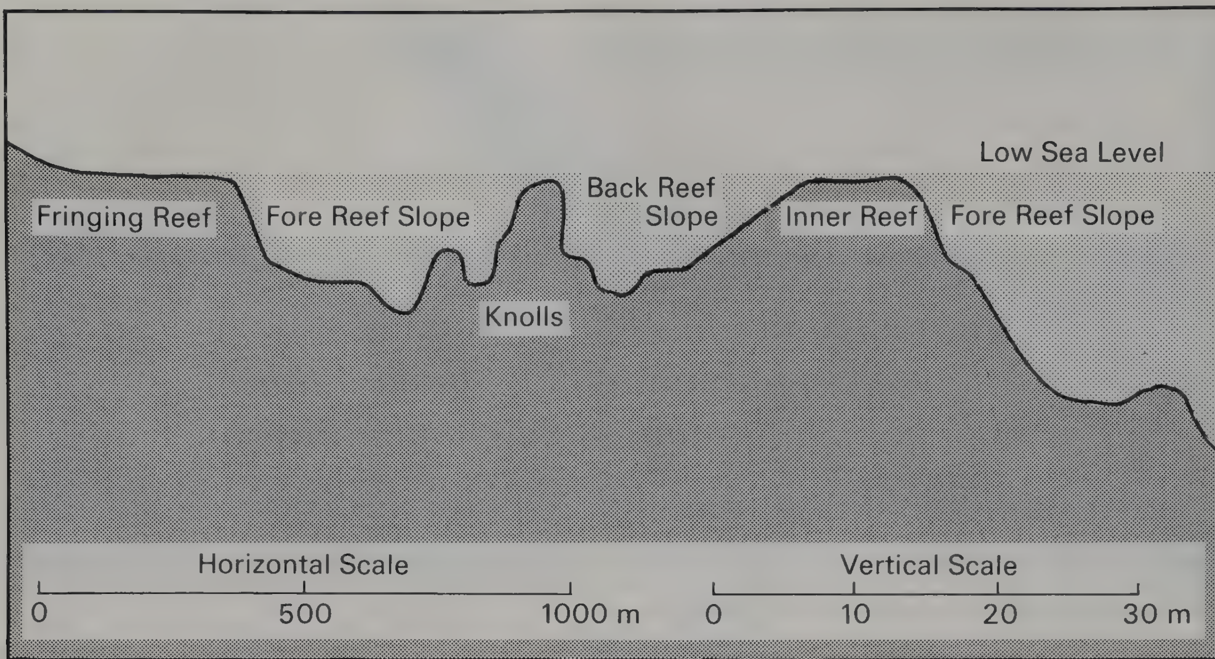


Fig. 4: Typical profile showing relationship between fringing reef and inner reefs.

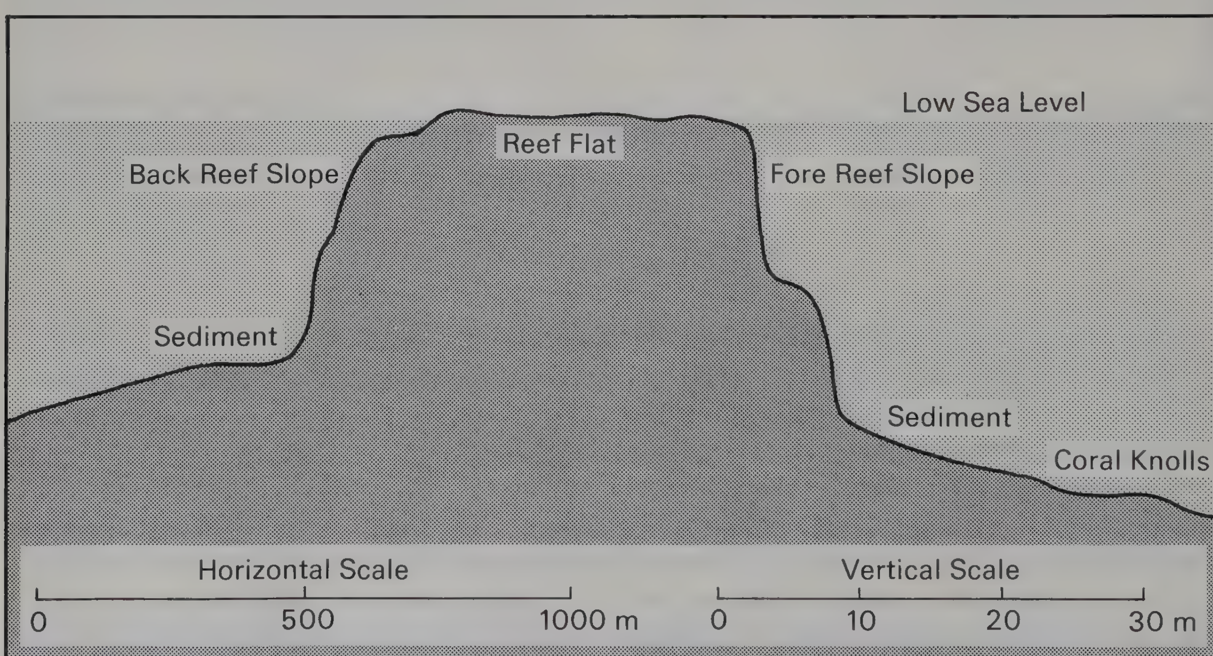


Fig. 5: Typical profile of mid and outer reefs, showing a steep sided reef located on a gently sloping base.

(2) Inner reefs. These are reefs close to shore, often only 400–500 m from it, but still separated from the fringing reef by soft substrate at a depth of over 10 m. Fig. 4 shows the profile of these and their relationship with the fringing reefs. The inner reefs include groups of simple, nearly circular patch reefs such as those in the southeast of the area, elongated ribbons running parallel with the shore and a complex of reefs which are separated from the fringing reef by a series of channels and holes. The fore reef slopes of the inner reefs descend steeply to about 20 m deep, from which point a more gentle gradient supports a mixture of sand and extensive coral growth which sometimes rises in broad knolls above the substrate.

The back reef slopes of the inner reefs show more variation than the fore reef slopes. At a few sites (S, T) there is extensive coral growth down to over 10 m deep, but in most cases there is only poor coral cover extending down to the soft substrate at less than 5 m.

(3) Mid reefs. To seaward of the inner reefs, or the fringing reef when the former are absent, the substrate shelves downwards to about 50 m over a horizontal distance of between approximately 1–3 km. Immediately before a steepening of the slope to 100 m deep there are several patch reefs, here termed mid reefs. All are small, having diameters of 200 m or less, but support very rich coral communities of high diversity. Their typical profile is shown in fig. 5.

(4) Outer reefs. The outer reefs are those located on an extensive offshore platform which is separated from the shore by water of at least 50 m deep and for the most part over 100 m deep, for a distance of about 5 km. The offshore, shallow platform is a major subsurface feature. It is about 10 × 40 km in size, and appears to be part of a much larger offshore structure which extends along much of the central Saudi Arabian coast, at least as far as Jeddah (Antonius, King Abdul Aziz University, Jeddah, personal communication). The surface of the platform is 20–50 m deep, with very high relief. Two echosounder profiles were made, whose tracks are shown in fig. 1. The bathymetric profiles are drawn in fig. 6. Trace A'A passed over an irregular surface with depressions to 55 m deep and submerged pinnacles reaching upwards to 30 m, while trace B'B passed over a smoother surface on the platform generally at 20 m deep.

Reefs reach the surface in groups on both the seaward and shoreward sides of the outer platform, but rarely between. These reefs range from small and circular to large and elongated ribbons, and include series of crescents and atoll like rings. Between the closely adjacent reefs on the platform, the substrate is largely sandy, the reefs appearing as large, steep sided blocks resting upon the platform. The outermost reef series is located at the extreme edge of the platform, such that the substrate plunges

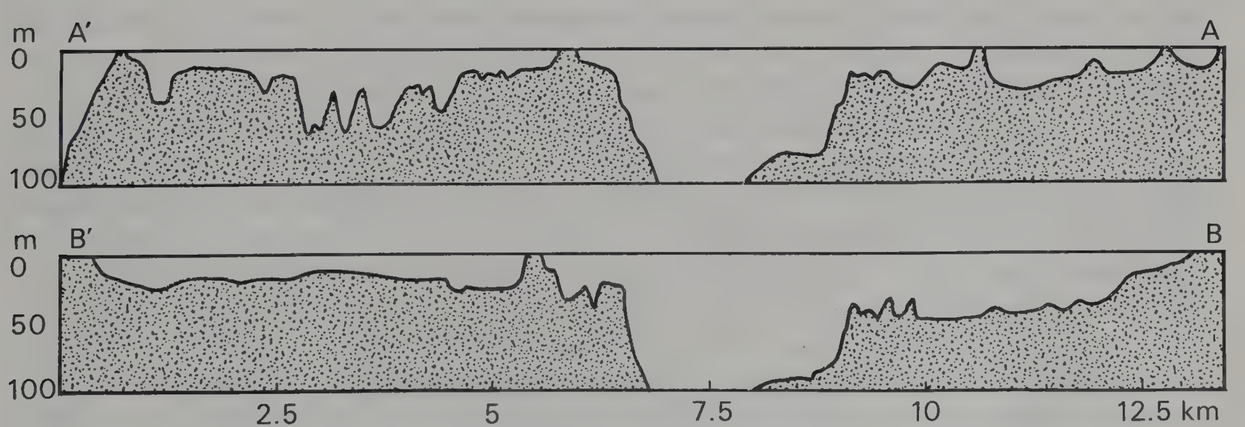


Fig. 6: Echosounder profiles across study site (tracks shown in fig. 1 as broken lines). Horizontal distance = 15 km, vertical extent = 100 m.

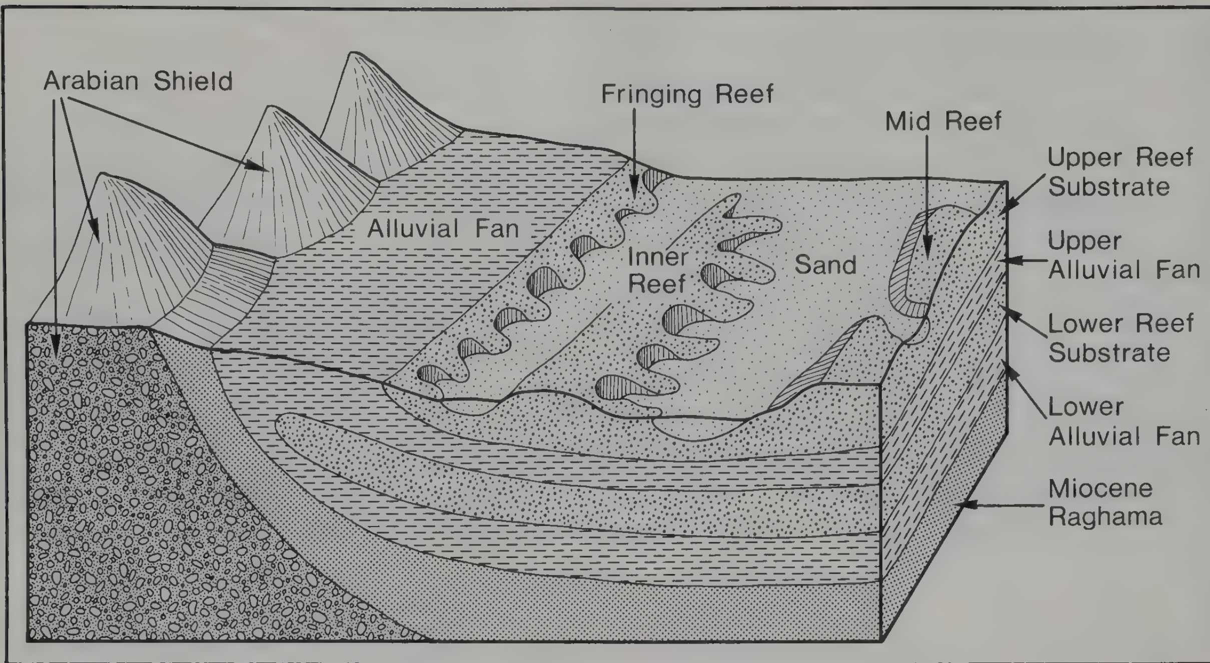


Fig. 7: Cutaway view of geological strata at Madinat Yanbu al Sinaiyah (from Fugro 1977).

steeply from the surface to over 500 m deep. The reefs on the shoreward side of the platform have a typical profile similar to that for the Mid Reefs shown in fig. 5. Their slopes descend steeply from low water level to a clearly defined juncture with a gently sloping substrate between 20–30 m deep. From the latter point, sand covers an increasing proportion of the surface. The back reef slopes of all the outer reefs are slightly more turbid than the fore reef slopes.

The subsurface character beneath the innermost reefs at Yanbu al Sinaiyah has been examined following a series of drilling investigations (Furgo 1977) whose data reveal a vertical pattern. According to the latter work, the growth of the present living reefs has proceeded over a large part of the Flandrian transgression, a period which could have enabled several metres of vertical reef growth to have occurred (Hopley 1982). The living reefs in this area lie over a series of different strata (fig. 7). About 20 m beneath the inshore area is a lithologic unit of alluvial material derived from the Precambrian, inland mountains. Twenty metres deeper is a lower reef unit consisting of coral colonies, calcareous algae and poorly sorted carbonates with traces of terrigenous grains. In some borings, another layer of alluvial fan was encountered below this. The account of this in Furgo (1977) relates the lowest sequence to the lowest still-stand at about 17,000 B. P., with the present, surface reaching reefs being less than 6,000 years old. It is known that fringing reefs may develop entirely on unconsolidated sediments (Hopley et al. 1983), and this appears to have been the case at Yanbu. The influence of the alluvial fans may not prove to be as important on the offshore platform, however, where the underlying foundations for the present reef may owe much to old, eroded limestone as was found with the reef systems at Port Sudan (Braithwaite 1982).

## Physical conditions in the survey area

Physical conditions vary across the survey area. Winds blow strongly from the northwest during the day such that the outer reefs receive the greatest wave energy, but cyclonic strength winds do not

**Table 1: Wave height at outer, inner and fringing reefs (from Georeda, 1982).**

| Wave rider position | Significant wave height (m): Median | 99th Percentile |
|---|---|---|
| Outer edge of offshore platform | 0.57 | 1.90 |
| Landward edge of offshore platform | 0.35 | 1.36 |
| Mid and inner reefs | 0.26 | 1.01 |
| Back reef slope, inner reefs and fringing reef | <0.15 | 0.67 |

occur. Measurements of wave energy (Tetra Tech 1980, Georeda 1982) show a marked attenuation of median wave heights towards the shore and inner reefs (tab. 1). From a median height of 0.57 m on the seaward side of the offshore platform, waves at the sheltered fringing reef have been reduced to a median height of <0.15 m due to the breakwater effect of the numerous reefs.

Throughout 16 months of visual observation, sedimentation was low and water clarity was high on the outer reefs, but both parameters deteriorated at the inner and fringing reefs. Back reef slopes in every case had higher turbidity than their corresponding seaward slopes. Temperature varies seasonally from 20–30°C at the surface (EESAL 1983) with thermoclines of about 2°C between 10–20 m deep. Salinity is about 40 ppt, slightly higher in winter and lower in summer (EESAL 1983). As is typical for reef water, nutrient levels were mostly very low with no gradients across the area.

## RESULTS

The coral assemblages on the wide range of reef habitats described above were examined using cluster analysis.

A dendrogram (fig. 8) and its diagnostics (tab. 2) show the result of the cluster analysis which is based on the 116 recognised species and species groups from the 101 sites examined. Appendix 1, which summarises the depth and slope of each site, also shows the clusters into which their coral assemblages fall. Thirteen clusters were distinguished by this analysis. The fusion level at which clusters are separated is an arbitrary decision, and in the present case it is drawn at a similarity level of 0.33, which is a level used elsewhere in the Red Sea (Loya 1972). Each cluster is thus at least two thirds dissimilar to each other.

Cluster 1 consists of the two surveyed reef flat sites plus two depauperate, shallow areas of reef slopes in turbid areas. These have very low coral cover and low diversity (tab. 2). The coralline alga *Porolithon* spp. dominates on all examined shallow water areas in these reefs.

Clusters 2–5 are all from shallow, seaward reef slopes and form a grouping which is well separated from others, by being dominated by one or more of four species of *Acropora*. The most exposed cluster, no. 2, is characterised by *Acropora humilis, A. hyacinthus* and *A.* cf. *danai* at covers of about 10% each. In slightly less exposed and deeper sites (cluster 3), cover by *A. humilis* decreases, leaving a higher cover of the other two *Acropora* species. Cluster 4 is distinguished by a high cover of *A. digitifera,* while the least exposed and deepest of this group, cluster 5, is dominated by *A. austera* and *Pocillopora verrucosa.* This coral assemblage also characterised the tops of patch reefs which did not reach the surface.

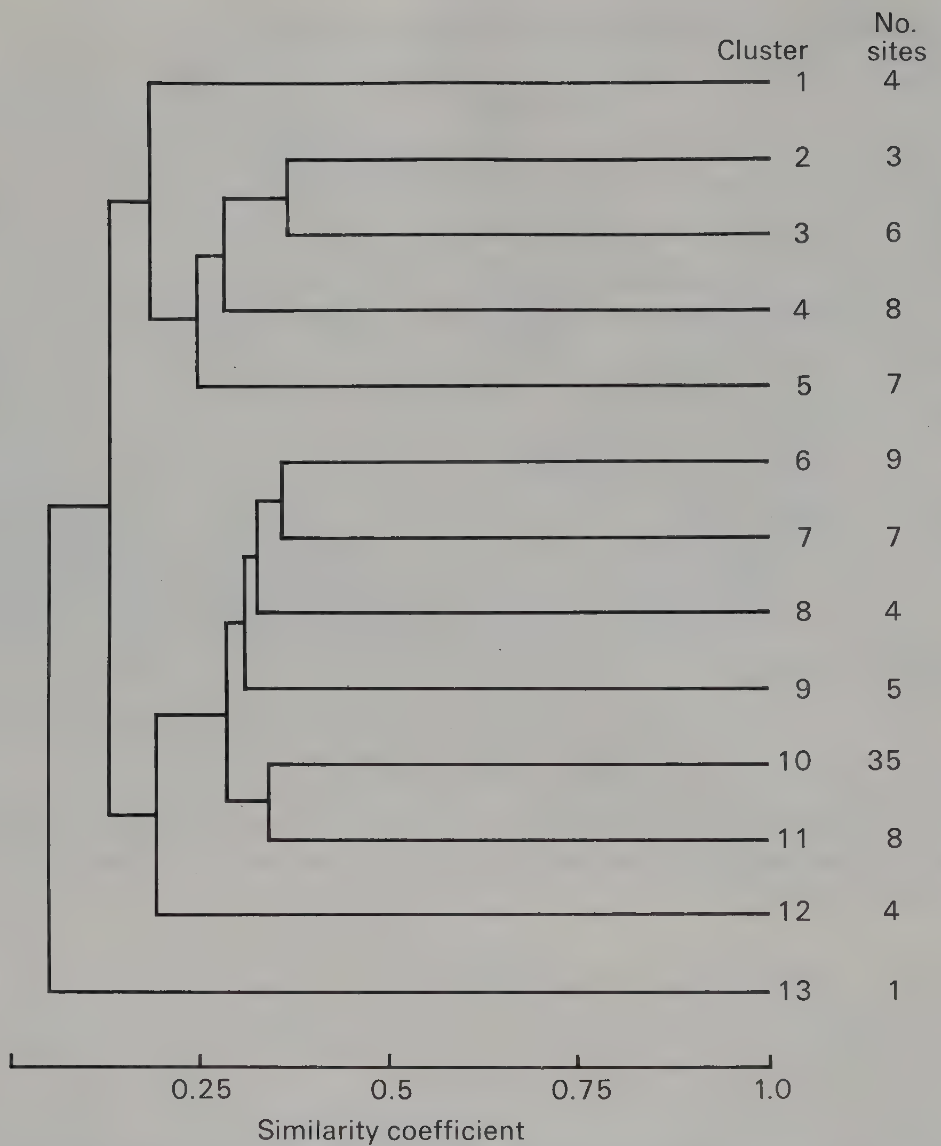


Fig. 8: Dendrogram from cluster analysis of 116 species or species groups at 101 sites, showing number of sites in each cluster and designation of cluster number.

These clusters and coral zones are clearly identifiable in the field, and their location may be predicted on the basis of relative exposure. Cluster 2 is a coral assemblage found in only the shallowest parts of seaward facing reef slopes between 0–2 m deep, while clusters 3–5 are found in areas which are progressively deeper. Most of the species noted (*A. hyacinthus, A. humilis* and *A. digitifera*) are common in shallow water over much of the Indo-Pacific, but the relatively brittle *A.* cf. *danai* has not been a widely recognised, dominant member of shallow, seaward reef slope assemblages. Its morphology is similar to many other branching species from shallow, exposed areas (Highsmith 1982), and exists in Yanbu amongst the breaking waves of the outermost reefs. In these stands, up to a quarter of the branches were found to be broken and detached, yet firmly held in place by adjacent, attached branches. Parts of the slope beneath such stands were thickly covered by dead branches of this species. It was not found in depths below 4–5 m.

Clusters 6–12 form a separate grouping, generally characterised by having higher coral species diversities. All occur in deeper and more sheltered locations than the previously mentioned clusters which are dominated by *Acropora*. Cluster 6 which is dominated by *Pocillopora verrucosa*, occurred immediately beneath cluster 5 discussed above. Clusters 7 and 10 are poorly distinguished, being separated only by a raised *Porites* cover in the former. Together, these two clusters include a third of all study sites, and occur in areas which typically do not suffer high exposure. Reef slope sites of low diversity such as those from turbid parts of the fringing reef also fell into these clusters; their coral faunas have no distinguishing species but are merely a subset of the total.

Where patch reefs exist in close proximity to each other, many seaward slopes are as sheltered as back reef slopes. These are designated "protected slopes" (PS in tab. 2). Three clusters contain a mixture of back reef and protected slopes. Cluster 8 occurs in areas where there is much sandy substrate, and is characterised by tabular *Acropora* species. Examples of these were found at the foot of the fringing reef and in deeper water on the back slopes of outer reefs. Clusters 9 and 11 are found on steeper slopes in a wide range of sheltered reef areas, often physically adjacent to each other. The former, which is dominated by *Millepora*, lies immediately above the latter which is dominated by *Porites lutea*. On several mid reefs, the entire back reef areas between 3–30 m have a very high cover (25–75%) of *Porites* sp. whose morphology is that of tall spires. This provided the highest cover values of any single species, and such areas clearly have a coral framework growth at least as great as seaward slopes. These sites formed cluster 12.

**Table 2: Characteristics of the 13 clusters of sites determined by cluster analysis. SS = Seaward Slopes, BS = Back reef Slopes, PS = Protected Seaward slopes.**

| Cluster (no. of sites) | Av spp. / site | Total spp. in cluster | Coral cover % ±s.e. | Depth (m) | Locations | Dominant corals | % cover |
|---|---|---|---|---|---|---|---|
| 1. (4) | 14.7 | 35 | 13±6.1 | 0–1 | reef flats | None (Algae 50%) | |
| 2. (3) | 20.3 | 36 | 57±3.0 | 0–3 | SS | *A.* cf. *danai* | 5–10% |
| | | | | | | *A. hyacinthus* | 5–10% |
| | | | | | | *A. humilis* | 5–10% |
| 3. (6) | 15.5 | 35 | 61±7.2 | 0–6 | SS | *A.* cf. *danai* | 20–50% |
| | | | | | | *A. hyacinthus* | 10–20% |
| 4. (8) | 20.7 | 55 | 65±3.1 | 0–6 | SS | *A. hyacinthus* | 15–30% |
| | | | | | | *A. digitifera* | 15–30% |
| 5. (7) | 20.3 | 48 | 63±5.2 | 2–9 | SS | *P. verrucosa* | 15–50% |
| | | | | | | *A. austera* | 10–40% |
| 6. (9) | 27.8 | 73 | 48±3.6 | 2–13 | Mixed | *P. verrucosa* | 5–10% |
| 7. (7) | 36 | 82 | 44±6.7 | 1–10 | Mixed | None | |
| 8. (4) | 32.8 | 65 | 46±4.2 | 3–15 | BS+PS | *A. clathrata* | 5–10% |
| 9. (5) | 29 | 65 | 34±1.8 | 2–10 | BS+PS | *Millepora* spp. | 5–10% |
| 10. (35) | 40 | 115 | 32±2.3 | 5–40 | Mixed | None | |
| 11. (8) | 29 | 89 | 42±5.3 | 5–20 | BS+PS | *P. lutea* | 5–25% |
| 12. (4) | 23.3 | 54 | 71±8.2 | 0–15 | BS | *Porites* sp. | 25–75% |
| 13. (1) | 14 | 14 | 10 – | 25–35 | BS | *Leptoseris* spp. | 5% |

Finally, cluster 13 contains one site at 30–35 m deep dominated by *Leptoseris* spp. (site T). Generally, depths greater than 35 m were not sufficiently surveyed in this study to justify separate groupings for analysis, so such areas were usually pooled with the deepest sites which had a more comprehensive examination. However, observation suggested that *Leptoseris* and other leafy agariciids become increasingly common below 30 m, so that more sites defined by these corals would be expected. Figs 9–15 show representative examples of several of the assemblages.

The analysis suggested that patch reefs which do not reach the surface have similar coral assemblages to reefs which reach the low tide level. Reefs submerged to 10 m deep have tops dominated by *Pocillopora verrucosa* and *Acropora austera,* and are thus found in cluster 5. Those which reach only to 20 or 30 m deep have diverse assemblages with greater amounts of *Echinopora* and *Alveopora* spp. and are found in clusters 7 and 10.

Except on parts of the fringing reef where sedimentation was high and on inner back reef slopes, coral and framework growth on reef slopes is vigorous (see tab. 2). Reef flats have both low cover and low diversity. The assemblages in exposed sites which are dominated by *Acropora,* clusters 2–5, have 15–20 coral species per site, but the most diverse sites are those found on the seaward reef slopes below the *Acropora* dominated areas. These have 28–40 species per site. They have a greater cover of alcyonarians also (15–40%) which are scarce in the shallow *Acropora* dominated areas.

On fore reef slopes, diversity rises with increasing depth to 10–20 m. On back reef slopes, peak diversity lies in slightly shallower water (see tab. 2). This contrasts with the pattern of coral cover which has a peak at about 1–4 m deep on all slopes.

The high diversity at 10–20 m on seaward slopes corresponds closely with the high diversity cluster 10. This is the largest cluster and contained a total of 115 species out of the total 116 (see tab. 2) and never had a cover by any one species of over 5%.

## DISCUSSION

Most of the 13 clusters, or coral assemblages, were found across a wide range of fringing to outer reefs, and only a few are limited to one or two of the reef categories described earlier. Of much greater importance than the category of reef in this respect is its aspect, in other words its position to seaward or leeward, its degree of protection by other reefs, and its depth. Such differentiation according to exposure is not unusual in coral communities elsewhere (Done 1982, Sheppard 1982). Most of the 13 clusters are readily distinguished in the field, a sole exception being clusters 7 and 10 which differ only in their relative cover by a *Porites* species.

The number of different coral assemblages at the study sites is considerably greater than has been recorded elsewhere in the Red Sea to date (Loya 1972, Mergner 1984) and is comparable to other areas within the Indo-Pacific where a much higher number of coral species occur. It is thus possible to place these Red Sea reefs in a broader Indo-Pacific context. Coral assemblages in the most exposed parts of the Yanbu reefs correspond closely with those from the most turbulent areas of the Great Barrier Reef and Coral Sea (Done, 1982; personal observation). On the Great Barrier Reef, Done (1982) reported considerable overlap in the species composition of communities, but could differentiate most fairly easily by their dominant species. The same applies to the Yanbu reefs. In both regions, *Acropora humilis, A. hyacinthus* and *A. digitifera* are characteristic of high energy. Similar species combinations exist on exposed parts of numerous other reefs as well, such as Aldabra atoll (Barnes et al. 1971), the Maldives (Scheer 1972), Madagascar (Pichon 1978), the northern Great Barrier Reef (Veron 1978), and Chagos (Sheppard 1980, 1982). Therefore, although overall energy conditions in the central Red Sea are certain-

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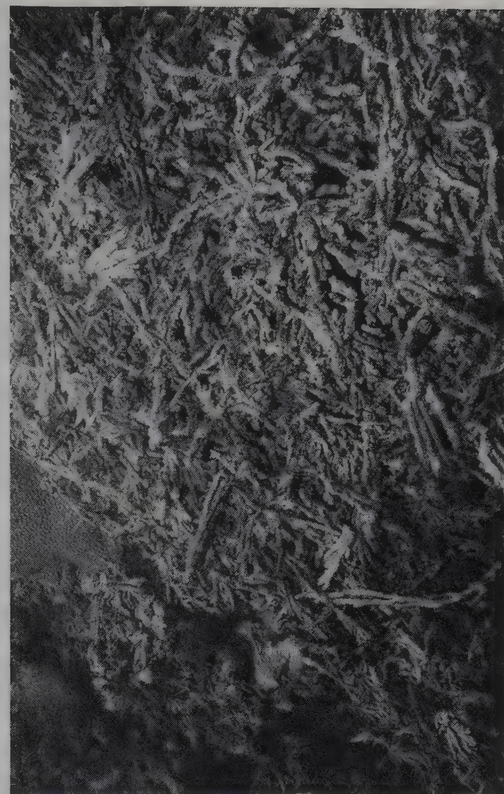

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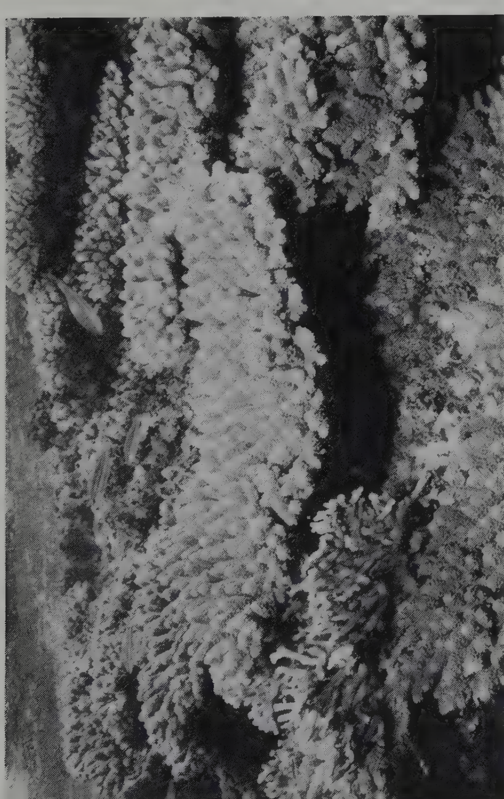

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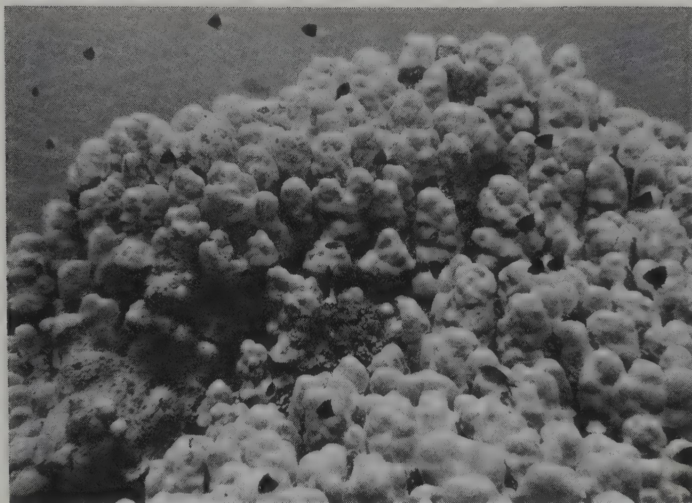
Figs 9–12: 9, Part of cluster 2 community with *Acropora humilis* dominant, 1 m deep; 10, seaward slope of protected reef with *Pocillopora* spp. and *Stylophora pistillata*, 3 m deep; 11, *Acropora* cf. *danai* community (cluster 3) on outer reef, seaward slope, 1 m deep; 12, seaward slope at 10 m deep beneath site shown in 11, showing 1 m thick pile of dead *Acropora* cf. *danai*.

13



14

15


Figs 13–15: 13, *Porites* sp. 1 (cluster 12) on back reef slope of patch reef on inner shelf, showing typical growth form where species provided over 50% cover. 10 m deep; 14, 15, the tabular *Acropora* spp. (cluster 8), characteristic of flat, sandy, sheltered areas between patch reefs. 12 m deep.

ly lower than on the Great Barrier Reef and oceanic atolls, the former area supports comparable coral communities.

As expected when comparing areas of different diversity, the comparison is not exact. The Great Barrier Reef for example has four times more coral species than Yanbu. Thus species such as *Acropora palifera, A. palmerae* and *Pocillopora eydouxi* which feature strongly in exposed areas in the former are absent from the central Red Sea.

Further similarities occur in less exposed areas. Analogous *Porites* and tabular *Acropora* zones exist in both geographical regions (Done 1982; personal observation), but again, some of the diagnostic species of the Great Barrier Reef zones are absent from the Red Sea.

There is, however, almost no similarity in the coral assemblages in sedimented water. Six of Done's Great Barrier Reef clusters fall into this grouping, five of which are characterised by substantial cover by one or a few genera. In Yanbu, very turbid reef areas have no diagnostic species but contain low abundancies of a wide range of species. Sponges, filamentous green algae and alcyonarians are more constant components of sedimented areas in Yanbu.

A second useful comparison can be made with the coral zones determined for the fringing reef in the Gulf of Aqaba (LOYA 1972). There, his defined zones are: *Stylophora pistillata,* a *Millepora* zone, the *Echinopora gemmacea* zone, a zone of *Acropora hemprichii* and *A. variabilis,* and a *Porites lutea* zone from about 15 m deep (LOYA 1972, fig. 3). The *Millepora* and *P. lutea* zones exist at Yanbu. The others did not because although the species exist, they show constant, low to moderate abundance in most reef areas to at least 25 m deep. However, from the commonality which does exist (LOYA & SLOBODKIN 1971, LOYA 1972) the fringing reef of the Gulf of Aqaba can be seen to broadly correspond to the fringing reef or to a protected patch reef at Yanbu.

It has been predicted on the basis of coral cover and aesthetic value that coral reefs in the central Red Sea would prove to be the richest in terms of coral diversity (ORMOND et al. 1984). The present study confirms that coral diversity is greater in this central area of the Red Sea than it is further north, and it is also greater than that on the southern Red Sea coast of Saudi Arabia (SHEPPARD 1986). Perhaps more importantly, the cluster analysis shows also that the number of different coral assemblages is also substantially greater than is the case elsewhere in the Red Sea and compares favourably with several sites further east and far less peripheral in the Indo-Pacific Ocean. While the Red Sea is well known for its extensive fringing reefs, the present study suggests that its barrier reef system located a few km offshore is richer biologically and is perhaps of greatest importance as a resource area.

## ACKNOWLEDGEMENTS

This work was carried out as part of contract GST-4021 issued by the Royal Commission for Jubail and Yanbu, to Ecology and Environment Saudi Arabia Ltd. We are very grateful also to Mr. W. Hieber for extensive assistance during the survey.

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**Appendix 1: Descriptions of sites examined. See fig. 2 for locations of the reefs. "crest" is part of reef slope which adjoins reef flat, "hole" is a depression behind fringing reef.**

| Reef | Depth (m) | Slope° | Cluster |
|---|---|---|---|
| Outer reefs: | | | |
| A. front | 20–22 | 10 | 10 |
| | 13–18 | 10–45 | 10 |
| | 7–10 | 10–45 | 7 |
| | 0–6 | crest | 4 |
| B. back | 7–14 | 20 | 11 |
| | 3–6 | 10 | 11 |
| | 1–2 | crest | 9 |
| C. front | 0–2 | crest | 2 |
| | 3–7 | 45–90 | 7 |
| | 8–16 | 30–45 | 10 |
| | 18–24 | 20–30 | 10 |
| | 25–40 | 10 | 10 |
| D. back | 0–7 | 45–90 | 7 |
| E. front | 1–2 | crest | 4 |
| | 3–9 | 50 | 9 |
| | 10–13 | 5 | 11 |
| F. back | 3–5 | 80 | 8 |
| | 10–15 | 10 | 12 |
| | 17–20 | 5 | 11 |
| Mid reefs: | | | |
| G. front | 13–20 | 5 | 11 |
| | 6–10 | 45 | 6 |
| | 2–5 | crest | 4 |
| | 1–2 | crest | 4 |
| H. back | 1–10 | 30 | 12 |
| I. front | 1–2 | crest | 3 |
| | 3–6 | 30 | 3 |
| | 10–15 | 50 | 6 |
| | 17–20 | 5 | 10 |
| J. back | 0–3 | 45 | 12 |
| | 4–13 | 25 | 12 |
| | 17–20 | 5 | 10 |
| K. front | 22–30 | 10 | 10 |
| | 11–20 | 10 | 10 |
| | 7–10 | 45 | 4 |
| | 2–6 | crest | 5 |
| | 1 | crest | 3 |
| back | 1 | crest | 4 |
| L. back | 2–10 | 40 | 10 |
| Inner reefs: | | | |
| R. front | 1–3 | 50–80 | 3 |
| | 4–6 | 45–50 | 9 |
| | 10–17 | 25–35 | 10 |
| | 22–24 | 45 | 11 |
| S. back | 10–12 | 10 | 11 |
| | 5–6 | 45 | 7 |
| T. channel | 2–10 | 10 | 9 |
| | 12–13 | 20 | 10 |
| | 14–20 | 30 | 11 |
| | 23–29 | 45 | 13 |
| front | 0–6 | 15 | 5 |
| U. front | 0–2 | crest | 2 |
| | 2–6 | 45 | 3 |
| | 7–9 | 30 | 5 |
| | 10–13 | 20 | 6 |
| | 14–22 | 10 | 10 |
| | 23–27 | 5 | 10 |
| V. reef flat | 0 | flat | 1 |
| | 1–3 | 10 | 4 |
| | 5–8 | 15 | 4 |
| | 12–15 | 15 | 8 |
| | 18–21 | 45 | 10 |
| Y. front | 2 | 30 | 1 |
| | 3–4 | 20 | 6 |
| | 7–10 | 20 | 10 |
| | 15–20 | 15 | 10 |
| Z. back | 3–10 | 25 | 10 |
| | 2–3 | 45 | 6 |
| a. front | 0–1 | crest | 4 |
| | 3–5 | 30 | 10 |
| | 7–10 | 20 | 10 |
| Fringing reef: | | | |
| M. front | 1–3 | 3 | 2 |
| | 0–2 | 3 | 3 |
| | 3–4 | 3 | 5 |
| | 5 | 3–20 | 5 |
| hole | 1–3 | 90 | 10 |
| hole | 2–4 | 90 | 10 |
| N. front | 10–19 | 45–60 | 10 |
| | 5–2 | 30–45 | 9 |
| reef flat | 1 | flat | 1 |
| hole | 0–3 | 45–90 | 10 |
| O. front | 20–25 | 45–65 | 10 |
| | 6–8 | 20–45 | 6 |
| P. front | 12–18 | 45 | 10 |
| Q. front | 0–5 | 45 | 10 |
| W. | 0–3 | 45 | 1 |
| X. front | 1–2 | 0–30 | 5 |
| | 3–5 | 30 | 6 |
| | 6–8 | 0–30 | 8 |
| | 10–15 | 5 | 8 |
| b. front | 3–6 | 30 | 5 |
| | 8–10 | 30 | 7 |
| | 11–17 | 20 | 10 |
| | 21–28 | 20 | 10 |
| north of | 1–7 | 85 | 7 |
| Yanbu | 10–15 | 45 | 10 |
| | 25–25 | 70 | 10 |

**Appendix 2: The 116 coral species and species groups recognised in the coral survey. Their number (last column) refers to their coding used in the analyses.**

| Family | Genus | Species | Authority | No. |
|---|---|---|---|---|
| Thamnasteriidae | *Psammocora* | *explanulata* | Horst | 1 |
| | | massive group | | 2 |
| Astrocoeniidae | *Stylocoeniella* | *guentheri* | Basset-Smith | 3 |
| Pocilloporidae | *Pocillopora* | *damicornis* | Linnaeus | 4 |
| | | *verrucosa* | Ellis & Solander | 5 |
| | *Seriatopora* | *caliendrum* | Ehrenberg | 6 |
| | | *hystrix* | Dana | 7 |
| | *Stylophora* | *pistillata* | Esper | 8 |
| | | *wellsii* | Scheer | 112 |
| Acroporidae | *Montipora* | *danae* | (Edwards & Haime) | 20 |
| | | *floweri* | Wells | 21 |
| | | encrusting group | | 22 |
| | | foliaceous group | | 23 |
| | *Acropora* | *hyacinthus* | (Dana) | 9 |
| | | *cytherea* | (Dana) | 10 |
| | | *digitifera* | (Dana) | 11 |
| | | *humilis* | (Dana) | 12 |
| | | *stoddarti* | Pillai & Scheer | 13 |
| | | *austera* | (Dana) | 14 |
| | | *yongei* | Veron & Wallace | 15 |
| | | *valida* | (Dana) | 16 |
| | | *nasuta* | (Dana) | 17 |
| | | cf. *danai* | (Edwards & Haime) | 18 |
| | | *clathrata* | (Brook) | 19 |
| | *Astreopora* | sp. 1 | | 24 |
| | | sp. 2 | | 25 |
| Agariciidae | *Pavona* | *varians* | Verrill | 37 |
| | | *maldivensis* | (Gardiner) | 38 |
| | | cf. *explanulata* | (Lamarck) | 39 |
| | | *cactus* | (Forskal) | 40 |
| | | *decussata* | (Dana) | 41 |
| | | *duerdeni* | Scheer & Pillai | 49 |
| | *Leptoseris* | *yabei* | (Pillai & Scheer) | 44 |
| | | *hawaiiensis* | Vaughan | 45 |
| | | *tenuis* | Horst | 46 |
| | | *mycetoseroides* | Wells | 47 |
| | *Gardineroseris* | *planulata* | (Dana) | 42 |
| | *Pachyseris* | *speciosa* | (Dana) | 43 |
| Siderastreidae | *Coscinaraea* | sp. 1 | | 48 |
| | *Siderastrea* | *savignyana* | Edwards & Haime | 50 |
| Fungidae | *Cycloseris* | *vaughani* | (Boschma) | 51 |
| | *Fungia (Fungia)* | *fungites* | (Linnaeus) | 52 |
| | *F. (Danafungia)* | | | 53 |
| | *F. (Verrillofungia)* | | | 54 |
| | *F. (Pleuractis)* | | | 55 |
| | *Herpetoglossa* | *simplex* | (Gardiner) | 56 |
| | *Herpolitha* | *limax* | (Hottuyn) | 57 |
| | *Podabacia* | *crustacea* | (Pallas) | 58 |

| Family | Genus | Species | Authority | No. |
|---|---|---|---|---|
| *Poritidae* | *Porites (Porites)* | *lobata/lutea* group | | 27 |
| | | small massives | | 28 |
| | | *lichen* | Dana | 29 |
| | | sp. 1 | | 30 |
| | *Porites (Synaraea)* | *rus* | (Forskal) | 31 |
| | *Goniopora* | *lobata* | Edwards & Haime | 32 |
| | | large polyps | | 33 |
| | | small polyps | | 34 |
| | *Alveopora* | *spongiosa* | Dana | 35 |
| | | large polyps | | 36 |
| Faviidae | *Favia* | *stelligera* | (Dana) | 59 |
| | | *laxa/helianthoides* | | 60 |
| | | *favus* | (Forskal) | 61 |
| | | *matthaii* | Vaughan | 62 |
| | | cf. *speciosa* | | 63 |
| | | sp. 1 | | 64 |
| | | sp. 2 | | 65 |
| | *Favites* | *abdita* | (Ellis & Solander) | 66 |
| | | *halicora* | (Ehrenberg) | 67 |
| | | *peresi* | Faure & Pichon | 68 |
| | | *rotundata* | Veron et al. | 69 |
| | | *flexuosa* | (Dana) | 70 |
| | | *pentagona* | (Esper) | 71 |
| | | *chinensis* | (Verrill) | 72 |
| | | *complanata* | (Ehrenberg) | 73 |
| | *Goniastrea* | *pectinata* | (Ehrenberg) | 74 |
| | | *edwardsi* | Chevalier | 75 |
| | | *australensis* | (Edwards & Haime) | 76 |
| | *Platygyra* | *daedalea* | (Ellis & Solander) | 77 |
| | | *lamellina* | (Ehrenberg) | 78 |
| | *Leptoria* | *phrygia* | (Ellis & Solander) | 79 |
| | *Oulophyllia* | *crispa* | (Lamarck) | 80 |
| | *Hydnophora* | *exesa* | (Pallas) | 81 |
| | | *microconos* | (Lamarck) | 82 |
| | *Montastrea* | *curta* | (Dana) | 83 |
| | | *magnistellata* | Chevalier | 84 |
| | | sp. 1 | | 85 |
| | *Plesiastrea* | *versipora* | (Lamarck) | 86 |
| | *Diploastrea* | *heliopora* | (Lamarck) | 87 |
| | *Leptastrea* | *inaequalis* | Klunzinger | 88 |
| | | *purpurea* | (Dana) | 89 |
| | | *transversa* | Klunzinger | 90 |
| | *Cyphastrea* | *chalcidicum* | (Forskal) | 91 |
| | | *microphthalma* | (Lamarck) | 92 |
| | | sp. 1 (8 septa) | | 93 |
| | *Echinopora* | *lamellosa* | (Esper) | 94 |
| | | *gemmacea* | (Lamarck) | 95 |
| | | cf. *hirsutissima* | | 96 |
| Oculinidae | *Galaxea* | *fasicularis* | (Linnaeus) | 97 |
| | | cf. *astreata* | (Lamarck) | 98 |

| Family | Genus | Species | Authority | No. |
|---|---|---|---|---|
| Merulinidae | *Merulina* | *ampliata* | (Ellis & Solander) | 99 |
| Mussidae | *Blastomussa* | *merletti* | (Wells) | 100 |
| | | *loyae* | Head | 114 |
| | *Acanthastrea* | *echinata* | (Dana) | 101 |
| | *Lobophyllia* | *hemprechii* | (Ehrenberg) | 102 |
| | | *corymbosa* | (Forskal) | 103 |
| | | *hataii* | Yabe et al. | 104 |
| | *Symphyllia* | cf. *recta* | (Dana) | 105 |
| | | cf. *valenciennesii* | Edwards & Haime | 106 |
| Pectiniidae | *Echinophyllia* | *aspera* | (Ellis & Solander) | 107 |
| | | *echinata* | (Saville-Kent) | 108 |
| | *Oxypora* | *lacera* | (Verrill) | 109 |
| | *Mycedium* | *elephantotus* | (Pallas) | 110 |
| Caryophylliidae | *Plerogyra* | *sinuosa* | (Dana) | 113 |
| | *Gyrosmilia* | *interrupta* | Ehrenberg | 115 |
| Dendrophylliidae | *Dendrophyllia* | *micrantha* | Ehrenberg | 122 |
| | *Tubastraea* | *aurea* | Quoy & Gaimard | 120 |
| | *Turbinaria* | *frondens* | (Dana) | 116 |
| Hydrozoa | *Millepora* | all species | | 111 |

Note added in proof:

The following coral species have subsequently been identified from the collection. These formed parts of the unidentified groups in Appendix 2.

| | | |
|---|---|---|
| *Montipora* | *prollis* | Bernard |
| *Montipora* | *stellata* | Bernard |
| *Acropora* | *vaugnani* | Wells |
| *Acropora* | *polystoma* | (Brook) |
| *Porites* | *stephensoni* | (Crossland) |
| *Alveopora* | *tizardi* | Bassett Smith |

# Reefs and Coral Assemblages of Saudi Arabia 2. Fringing Reefs in the Southern Region, Jeddah to Jizan

C.R.C. Sheppard

Abstract: Fifty sites on 27 coral reefs were examined between Jeddah and the southern Saudi Arabian border. On each, details were obtained of topography, extent and development, and of their coral populations. Several gradients occur on this part of the Red Sea coast: (1) Reef development and their maximum depths both decline southwards. (2) The southernmost reefs are algal reefs. Coral reefs are not found in close inshore waters of the Saudi Arabian Red Sea south of Shuqaiq. All fringing reefs in this area, however, have dense covers of *Sargassum* between 0–1m deep. (3) Coral cover in shallow water (2–4 m deep) does not decline southwards but coral species diversity declines significantly as the reefs become simpler and have fewer habitats. At least 35 species or species groups which are common in the northern and central Red Sea disappear on this part of the coast, some continuing as far south as Jeddah, and others penetrating further into the survey region. Soft corals and *Millepora* also disappear towards the south. (4) Five coral species show a reverse gradient; they are common in the Indian Ocean and penetrate northwards into the survey area but disappear before Jeddah is reached.

Six coral assemblages are identified. One is found on the low diversity algal reefs, one is a high diversity assemblage without dominant species, three are dominated by various *Porites* species, some in conjunction with other genera, and one is dominated by *Acropora*. Four of these show a geographical separation and at least one of the coral assemblages is a result of very high turbidity near mangrove stands. Coral diversity and the number of coral assemblages is significantly reduced in this survey area compared with northern and central parts of the Red Sea, and this reduction corresponds with an increase in the extent of soft substrate ecosystems.

Keywords: Reefs, corals, southern Red Sea, zoogeography.

تجمعات الشعب المرجانية في المملكة العربية السعودية

٢ • الشعب المرجانية الهدابية في المنطقة الجنوبية (من جدة الى جيزان)

سي • ر• سي • شيبارد

خلاصة : تم دراسة ٥٠ موقعا تقع ضمن ٢٧ من الشعاب المرجانية الممتدة بين جدة والى الحدود الجنوبية للمملكة العربية السعودية • ولكل من هذه المواقع ، تم الحصول على معلومات مفصلة تتعلق بطبوغرافية وامتداد ونمو جماعات الشعب المرجانية • وهناك عدد من النماذج تتواجد في هذا الجزء من شواطيء البحر الاحمر ، وهي : ١- يقل نمو وأقصى عمق للشعب المرجانية في اتجاه الجنوب • ٢- تتألف الشعب المرجانية في اقصى الجنوب من شعاب طحلبية • ولا توجد شعب مرجانية في المياه الساحلية من البحر الأحمر الى الجنوب من الشقيق ، ويغطي Sargassum بكثافة الشعاب الهدابية في هذه المنطقة على أعماق تتراوح بين صفر - ١ متر • ٣- لا يقل الغطاء المرجاني في المياه الضحلة (٢-٤ متر في العمق) في المنطقة الجنوبية ، ولكن أنواع المرجان تقل بشكل ملفت للنظر ، حيث تصبح الشعاب أبسط وتقل مواطنها • ان هناك ٣٥ نوعا أو مجموعات انواع شائعة الانتشار في شمال ووسط البحر الاحمر • تختفي في المنطقة الجنوبية ، ويمتد البعض منها الى الجنوب حتى جده والبعض الآخر يمتد الى أبعد من ذلك ليصل الى منطقة الدراسة • كذلك تختفي المراجين الطرية و Millepora في الجنوب • ٤- أظهرت ٥ أنواع من الشعب المرجانية نماذج مخالفة لما سبق ، ان هذه الأنواع شائعة الانتشار في المحيط الهندي وتمتد نحو الجنوب الى منطقة الدراسة ولكنها تتلاشى قبل بلوغها منطقة جده •

ولقد تم تعريف ستة أشكال من التجمعات المرجانية . أحدها موجود في منطقة الشعاب الطحلبية ، وآخر في منطقة التنوع الكثير وتدون نوع سائد ، وثلاثة تجمعات تسود فيها عدة أنواع من Porites ، والبعض منها مكون من اتحاد مع آجناس اخرى ، والاخير يسود فيه نوع Acropora . ولقد أظهرت أربعة من التجمعات المرجانية انفصالا جغرافيا وعلى الاقل واحدا منها نتج عن عكران شديد بالقرب من مناطق التفرع . ان التنوع وعدد التجمعات المرجانية منخفض بشكل ملحوظ في منطقة الدراسة اذا ما قورن بالاجزاء الشمالية والوسطى من البحر الأحمر ، وهذا الانخفاض نتيجة لزيادة امتداد القاع اللين في المنطقة الجنوبية .

## INTRODUCTION

The fauna in the Red Sea has commonly been regarded as belonging to one zoogeographical sub-province, namely a western extension of the Indo-Pacific Ocean which has a high degree of endemicity. Although considerable research has taken place on the coral reefs of the Red Sea (for review see MERGNER 1984), until very recently there have been too few benthic data which could be used to search for distribution patterns within the Red Sea itself (ORMOND et al. 1984a). ROSEN (1971), building on the work of STEHLI (1968) and STEHLI & WELLS (1971), first discussed gross diversity patterns in corals at generic level within the Red Sea and suggested that a peak of over 50 coral genera may be expected in the southern part, with a decline northwards (his figure 2). His proposed decline towards the north was a logical extension of the general Indo-Pacific trend of generic diversity.

In fact, the combined lists of SCHEER & PILLAI (1983), SHEPPARD & SHEPPARD (1986) and the present work show that nearly eighty genera, comprising about 250 species (including ahermatypes) exist in the Red Sea. About 54 genera occur in the central Red Sea at Yanbu (SHEPPARD & SHEPPARD 1986), and about 40 genera have been recorded from the northern Red Sea (LOYA & SLOBODKIN 1971). However, there is still no work reported on coral distribution patterns in the southern Red Sea although early work has indicated that the diversity in the south is much lower than expected (WAINWRIGHT 1965) even in the islands of the Dahlak and Farasan Archipelagoes. In the former, it was reported that there were no true or actively accreting coral reefs but merely veneers of corals on older reef substrates, a view confirmed by Goreau (in WAINWRIGHT 1965). In particular, the main reef building genera *Acropora* and *Porites* were absent or poorly represented on most of the reefs examined. Later work in the Dahlak Archipelago has been mainly geological (ANGELUCCI et al. 1981, CIVITELLI & MATTEUCCI 1981) but has also suggested that substantial reef development and coral diversity are both limited, while surveys of the Farasan Archipelago (ORMOND et al. 1984a) did not examine the coral distributions in detail.

Some general faunal patterns in the Red Sea as a whole were clarified by surveys along the Saudi Arabian coast by ORMOND et al. (1984a, b, c) who combine data principally from the distributions of fish and seagrasses, but from reef quality, mangroves, echinoderms, molluscs and birds as well, to propose four biogeographic sub zones (fig. 1). The first sub-zone is mainly the Gulf of Aqaba. Sub-zone 2 extends southwards from this to a point between Yanbu and Jeddah. Sub-zone 3 extends along the coast a further 200 km, but also includes the outer parts of the Farasan Archipelago which lies offshore further to the south. Sub-zone 4 encompasses the southernmost part of Saudi Arabia, along the coast.

The present work was carried out as part of an investigation by the Meteorology and Environmental Protection Administration (MEPA) and the International Union for the Conservation of Nature and Natural Resources (IUCN), to identify the distribution and status of key marine habitats of the Red Sea coast and to provide recommendations for their conservation. It principally concerns the corals and reefs of sub-zone 4 as defined above. It includes, however, sites in sub-zone 3 as far north as Jeddah, to enable a better perspective to be gained of the context of the southern reefs in Red Sea as a whole. For the same reason, reference is also made to results in part 1 of this series from reefs in Yanbu the

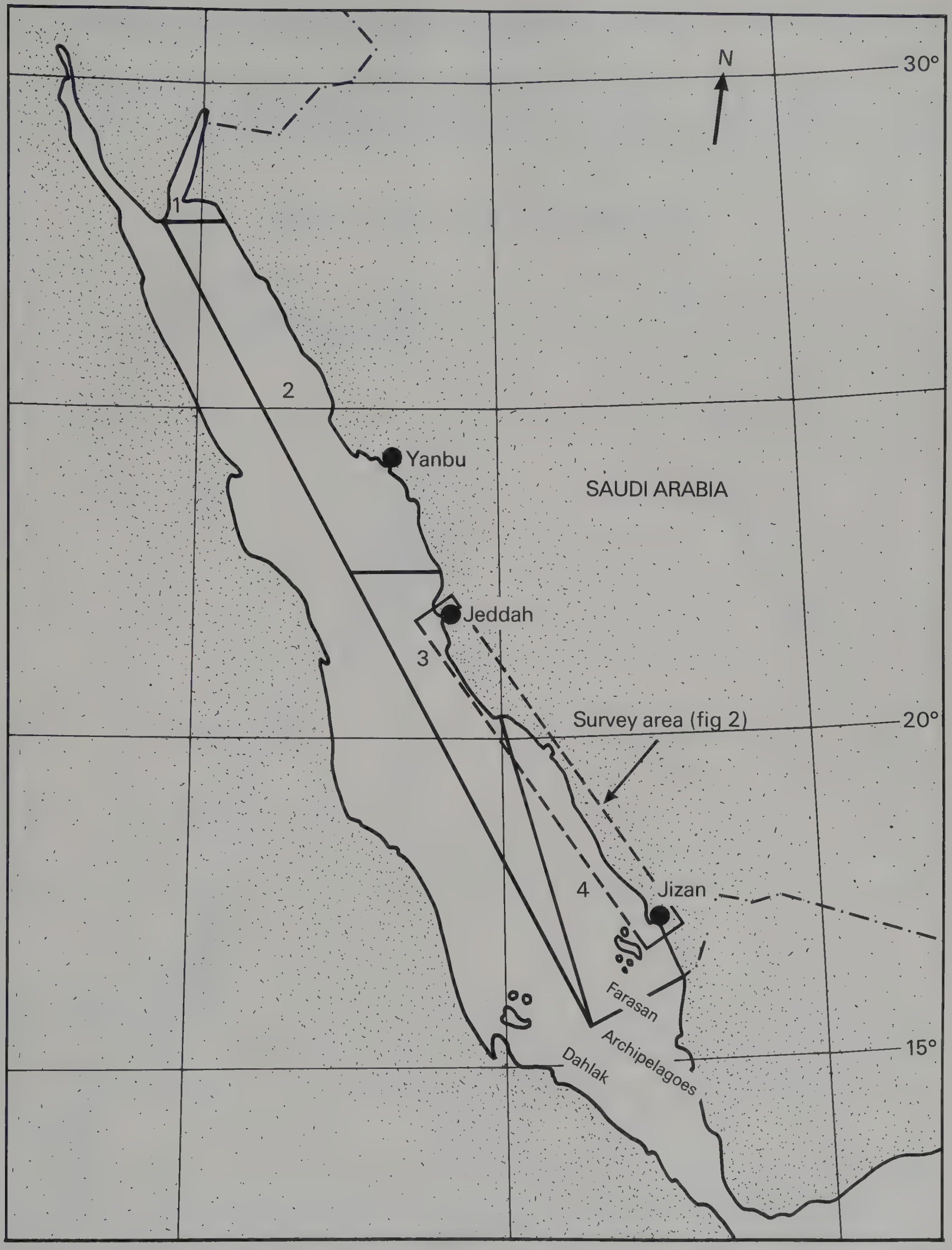


Fig. 1: Map of the Red Sea showing the 4 biogeographic sub-zones defined by ORMOND et al. (1984c). The present survey area is shown enclosed in a broken line, and encompasses the coast between Jeddah and the southern border of Saudi Arabia.

central Red Sea (SHEPPARD & SHEPPARD 1986) which is in sub-zone 2 in the scheme of ORMOND et al. (1984a).

Three aspects of the southern Saudi Arabian reefs are discussed: 1. The morphology of the fringing reefs and the identity of their main coelenterate and hermatypic components are described, 2. The corals and coral assemblages are analysed, and 3. The findings are discussed in the context of the Red Sea as a whole.

## METHODS AND THE SURVEY AREA

The extent of the survey area within the Red Sea is given in fig. 1, and fig. 2 shows the survey area and the location of all fringing reefs within it. Between Jeddah and Al Lith, coral reefs are more abundant than is indicated by the frequency of survey sites shown in fig. 2, but this part lies outside of the area designated for the survey. South of Al Lith, the frequency and distribution of survey sites approxi-

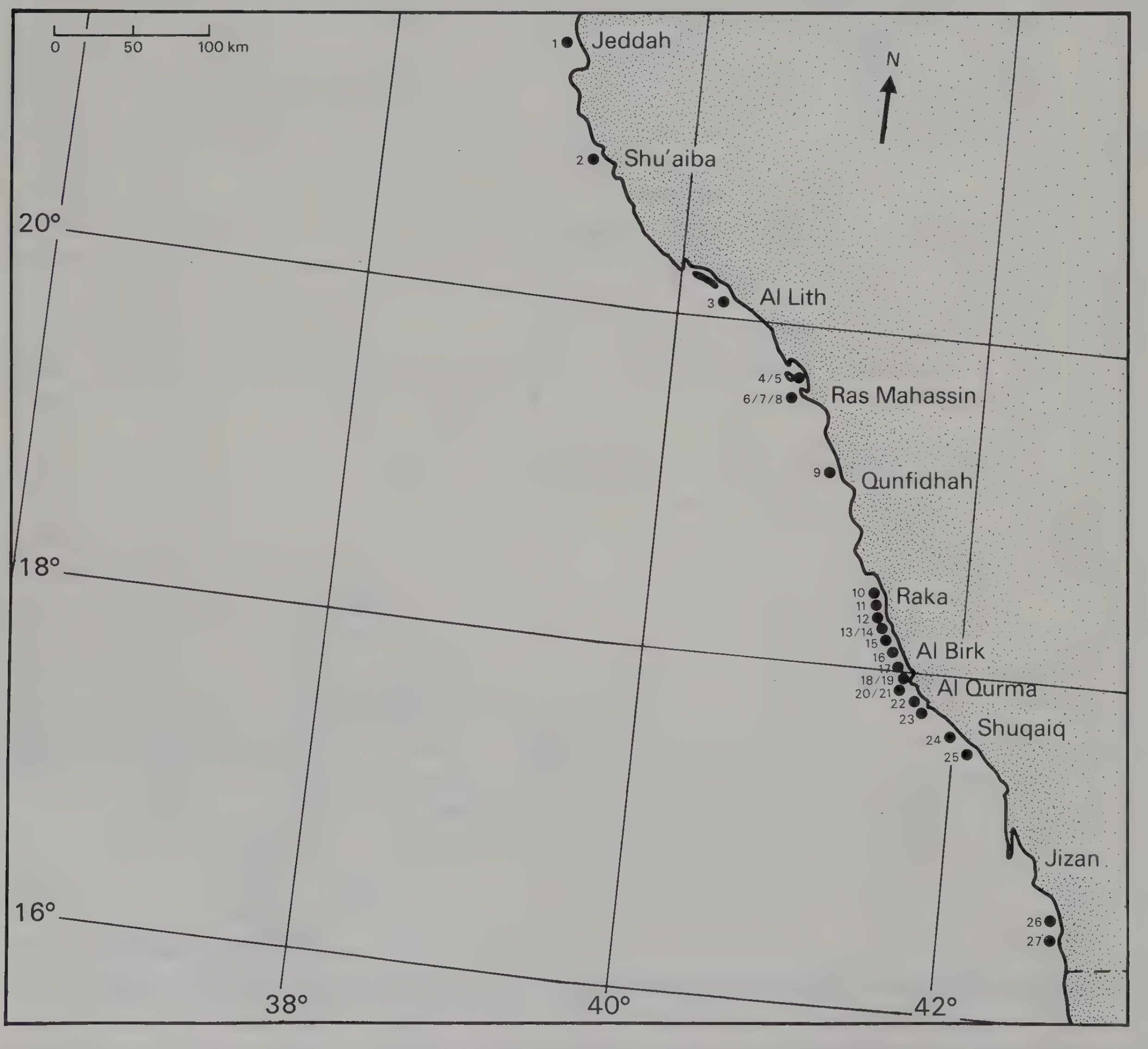


Fig. 2: Map of the coastline showing survey sites. Each numbered dot represents a reef area examined. Some dots carry two or three numbers indicating closely adjacent sites. The sites are described in Appendix 1.

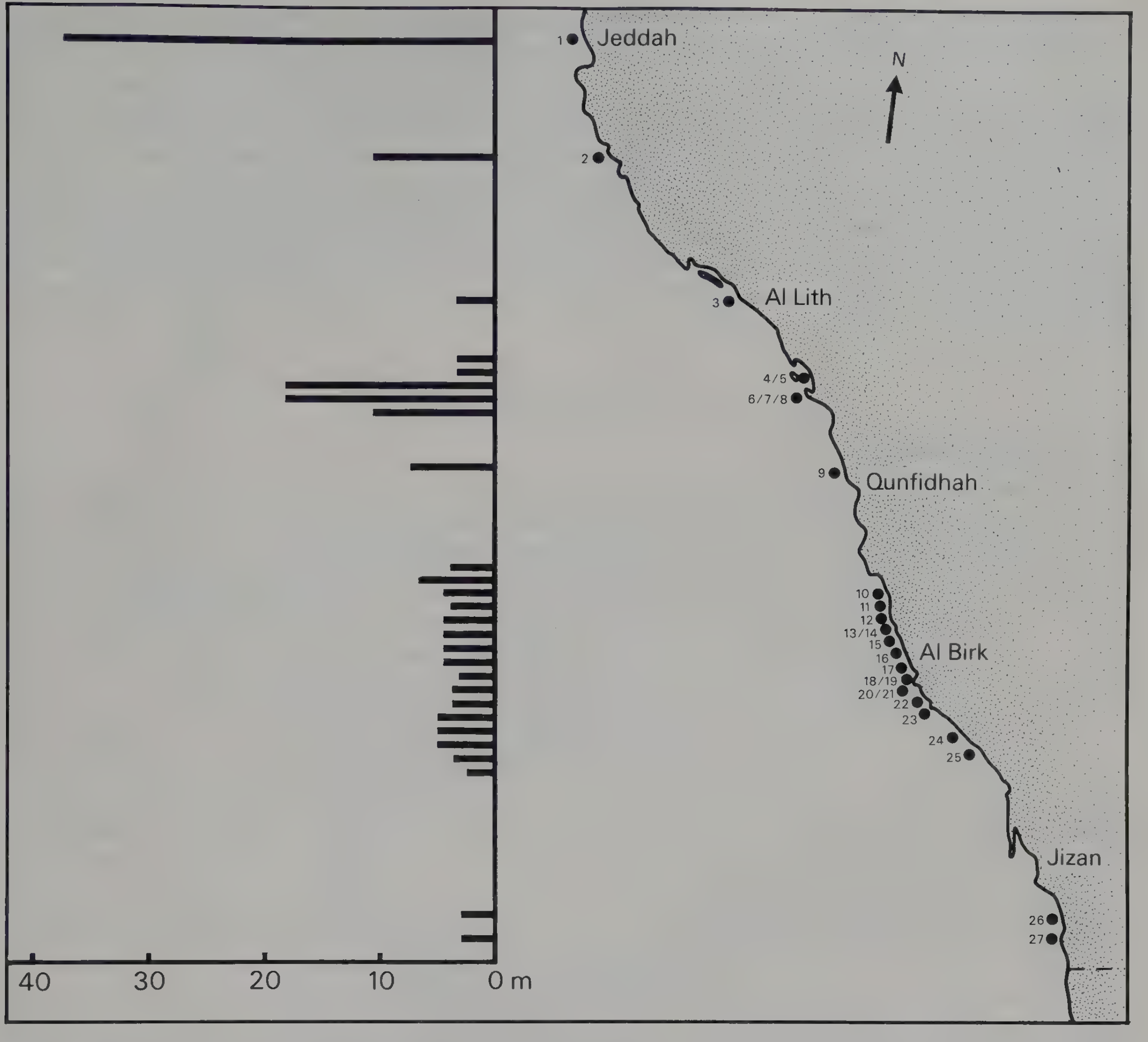


Fig. 3: Histogram of maximum extent of reef slope at each reef site. Each bar of the histogram is positioned to correspond with the site which it represents.

mately reflects those of the reefs themselves. The Qunfidhah area is perhaps under-represented since several kilometres of fringing reef exists there which was surveyed at one central site. The most extensive stretches of reef within the survey area are found to the north and south of Al Birk (see fig. 2). This is not continuous due to the frequent occurrence of mangrove, but between sites 10 and 23 fringing reefs extend along more than 50% of the coast. South of site 23 reefs become very infrequent along the shore.

I examined all reefs on foot across the reef flat and by Scuba to the base of the reef slope where the substrate gave way to nearly horizontal sediments. It was found that there were four main morphological categories of fringing reef. From the 27 reefs a total of 50 sites were selected for examination in the same manner as described in part 1 of this series for reefs at Yanbu in the central Red Sea (SHEPPARD & SHEPPARD 1986). Appendix 1 describes all the reef sites surveyed, including their depth spans and slopes.

Corals were then recorded at each site from an area of at least 500 $m^2$ together with the percent cover of all species which appeared to cover over 2% of the substrate. At each site, eye estimates were also made of total coral cover, soft coral cover, algal cover and type, and cover by soft substrate or other major substrate or faunal features. A cluster analysis was performed on the matrix of species at the 50 sites. The method chosen used the quantitative Bray Curtis (1957) similarity index, followed by a simple hierarchical clustering of sites and groups of sites (Sneath & Sokal 1973, Van den Hoek et al. 1975), where two sites, once matched, were replaced by their centroid which was determined as the arithmetic mean of the similarity coefficients. The clusters, or coral assemblages, were then defined as the groups which appear in the resulting dendrogram at a similarity level of 0.33; in other words, each cluster is at least two thirds dissimilar to each other cluster.

## RESULTS

### A. The survey area

As noted above, fringing reefs are not continuous within this area. From Jeddah to about 20 km north of Al Lith, reefs appear to be well developed, but south of Al Lith they tend to alternate with long stretches of mud and mangroves, and, further south, with sand which is derived partly from terrestrial dunes as well. Throughout this area, water deeper than 20 m is not reached for a least 1 km offshore, and often further. This inhibits reef slope development even where reefs exist. Overall, reef development becomes progressively weaker south of Jeddah compared with the central and northern Red Sea, and their distribution becomes more sporadic, until they all but disappear south of Al Qurma.

The depths to which coral reefs descend are shown graphically in fig. 3. These decrease significantly towards the south (Spearman rank coefficient: $-0.432$, $p<0.05$). In each case, sand or mud marks the foot of the reef slopes. On the fringing reef at the most northern site, hermatypic coral growth continues down to 35 m. South of this, at Shu'aiba, it reaches only to 12 m deep, although offshore reefs in this area undoubtedly extend deeper (see Ormond et al. 1984a, c). At Ras Mahassin (sites 6–8), both the fringing reef slope and the seaward reef slope of a patch reef 1 km offshore extend to 20 m deep, but from this point southwards no reef slopes were found which extend deeper than about 4 or 5 m.

Between Al Lith and Al Birk the continuity of the fringing reefs was interrupted by extensive mangroves and mud flats. Many of the survey sites were taken along the mid point of stretches of fringing reef only 2–4 km long and which were bounded at either end by mangrove. To the south of site 23, however, no fringing coral reefs were found. The reefs beyond this point are constructed entirely of calcareous algae (later section).

Reef flat development shows no clear geographical trends along the north-south gradient. The seaward edges of all reef flats have substantial calcareous red algal growth, and appear to be growing seaward to some degree. Those examined range from about 25 m wide (at Al Lith) to well over 200 m wide in several places. The width of the reef flat shows a slight relationship to sedimentation and proximity to mangroves or other areas with extensive mud. Sedimented sites such as Al Lith and several in the Al Birk section have very narrow reef flats, while sites located a kilometre or more from mangroves tend to be broader. Even the broadest flats usually have a veneer of fine sand and mud on their shoreward side, however.

Some sites have raised fossil reef (e.g. site 26), while others showed fossil reef at sea level. The best example of the latter is at site 25 where the shoreward side of the reef flat, which is at high water level, has large numbers and a high diversity of fossil coral colonies. The present, living reef almost entirely lacks corals. Conditions for coral growth in the past at these southern sites appear to have been better than those which now prevail.

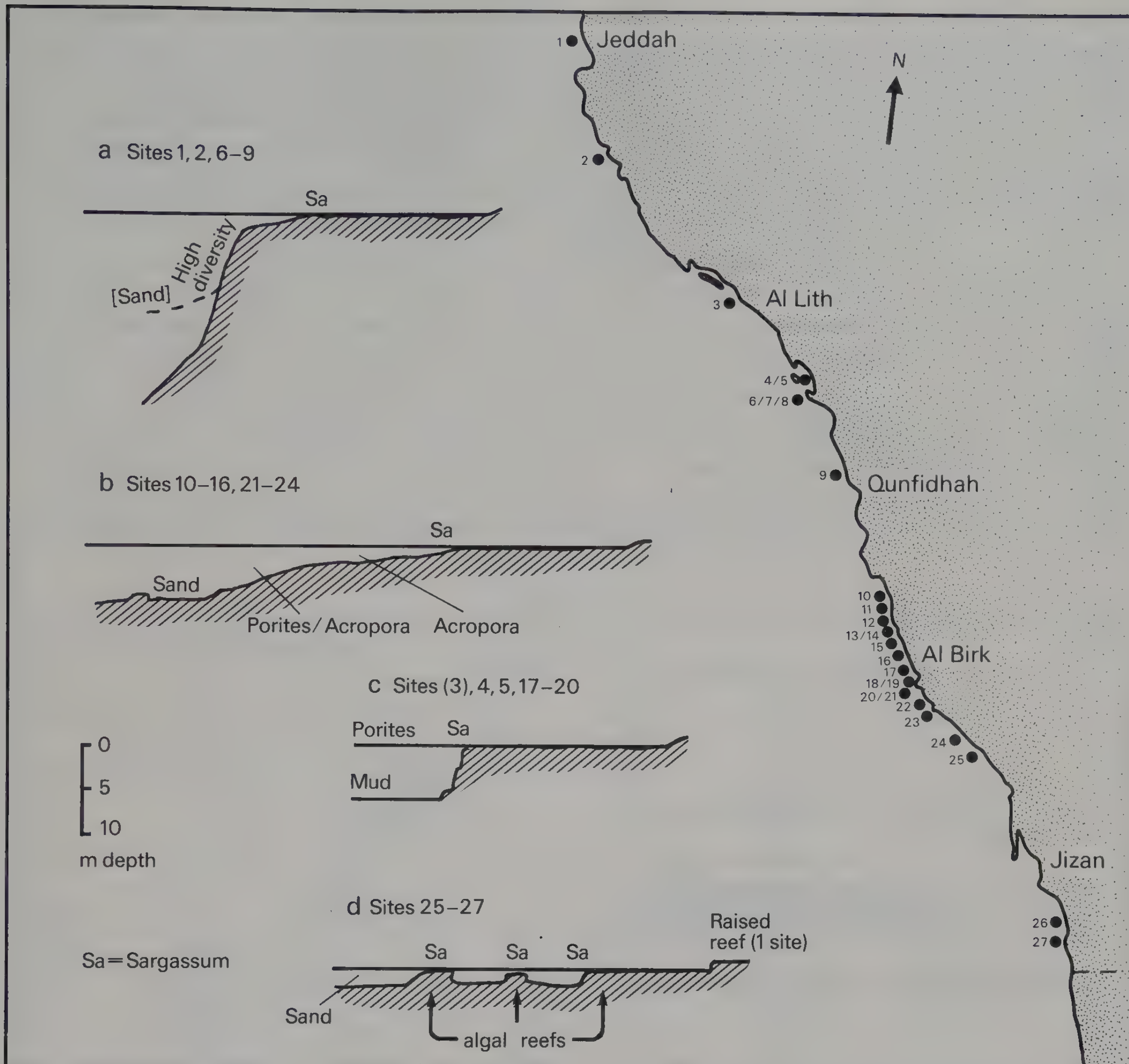


Fig. 4: Profiles of the four main types of reef in the survey area. Details and descriptions of each are given in the text.

All of the fringing reefs examined may be placed into four broad categories. Profiles of each are shown in fig. 4a–d, while tab. 1 lists the sites which fit each profile, together with a summary of relevent physical data. In the north of the survey area, classical Red Sea coral reef profiles are found. These have well developed reef flats, a gentle terrace dipping to 2–3 m, followed by a steeper drop. Depending on the depth at which soft substrate appears, the reef has a more gentle incline again below the steep drop off. Fig. 4a illustrates these.

Most of the reef sites examined have a maximum extent of about 5 m, which is reached with a very gentle slope (fig. 4b). These are dominated by *Acropora.* They are not found closely adjacent to mangroves or muddy influences.

Where mangroves occur nearby, or where other muddy habitats are present such as wadi outfalls or other embayments, reef slopes descend much more steeply (fig. 4c). The maximum depth remains the same, but the descent to it is often vertical, and the slope is dominated by *Porites.* On these, the sediments are very fine, and during the period of the survey water turbidity was always markedly lower than on the *Acropora* reefs.

**Table 1: Some physical characteristics of the four general reef types found along the Saudi Arabian coast south of Jeddah.**

| Type | Classical Red Sea reef | Clear water southern reef | Turbid water southern reef | Algal reef |
|---|---|---|---|---|
| illustrated | fig. 4a | fig. 4b | fig. 4c | fig. 4d |
| site numbers | 1, 2, 6, 7, 8, (9) | 10, 11, 12, 13, 14, 15, 16, 21, 22, 23, 24 | (3), 4, 5, 17, 18, 19, 20 | 25, 26, 27 |
| max depth (m) slope | >10m (no. 9 = 7 m) | 4–5 m | 4–5 m | 3 m |
| angle of slope | 30° to vertical | <10° | 30° to vertical | no true reef slope |
| sediment at base of reef | coarse sand | coarse sand | silt/mud | coarse sand |
| dominant corals | zones change with depth | *Acropora* | *Porites* (no. 3 = *Galaxea*) | none |

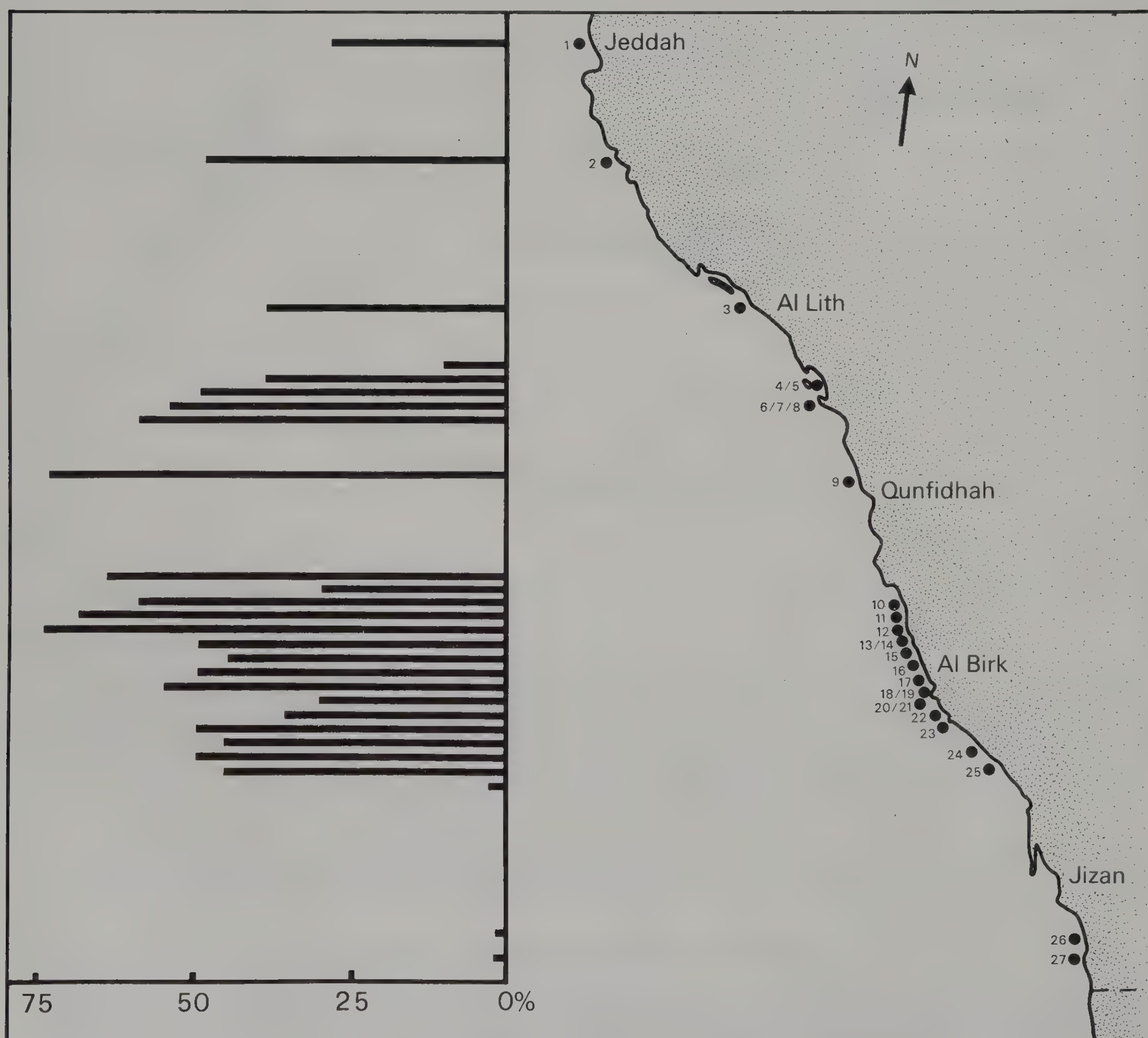


Fig. 5: Histogram of coral cover (%) at 2–4 m deep on each reef slope.

The fourth reef type is entirely different (fig 4d) and may be termed an algal reef. In this region, all reefs south of Jeddah have a reef crest and reef slope zone down to about 1 m deep which is constructed and dominated by red calcareous algae of the *Porolithon* group. These calcareous algae form a firm substrate, attached to which in every case are dense stands of the brown macrophyte *Sargassum*. The fourth reef type, which is found only in the far south of the survey area, consists only of this reef crest and shallow algal zone. These reefs are conspicuous from shore due to the abundant *Sargassum* which breaks the surface and marks the presence of the fringing reef edge or patch reef, but their vertical extent is a maximum of 3 m deep and corals are a negligible component of them. The commonest coral species is *Siderastrea savignyana* which is very uncommon elsewhere on the Saudi Arabian Red Sea coast.

The best example of this type of reef is the simple fringing reef at site 26, where there is a straightforward, though short, reef slope at the seaward edge of a 200 m wide reef flat. On this reef flat there is a high diversity of fossil corals of species which are now not found living on the reef. To seaward of the simple reef slope there is a broad expanse of coarse sand at 2–3 m deep extending at least another 200 m seaward. Scattered on this sand are more patches of red, calcareous algal reef, all supporting abundant *Sargassum* which breaks the surface of the water. Site 27 is similar though less extensive, while site 25 is a patch of algal reef located about 100 m off a sandy beach.

**Table 2: Species and species groups of corals found on the fringing reefs south of Jeddah. The numbers (last column) are the coding used in the analyses.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Psammocora* | *explanulata* | Horst | 1 | *Porites* | *lichen* | Dana | 29 |
| | massive group | | 2 | | sp. 1 | | 125 |
| *Stylocoeniella* | *guentheri* | Basset-Smith | 3 | | sp. 2 | | 30 |
| *Pocillopora* | *damicornis* | Linnaeus | 4 | | cf. *rus* | (Forskal) | 31 |
| | *verrucosa* | Ellis & Solander | 5 | *Goniopora* | *lobata* | Edwards & Haime | 32 |
| *Seriatopora* | *caliendrum* | Ehrenberg | 6 | | large polyps | | 33 |
| | *hystrix* | Dana | 7 | | small polyps | | 34 |
| *Stylophora* | *wellsii* | Scheer | 8 | *Alveopora* | sp. 1 | | 35 |
| | *pistillata* | Esper | 9 | *Favia* | *stelligera* | (Dana) | 60 |
| *Acropora* | *hyacinthus* | (Dana) | 10 | | *favus* | (Forskal) | 62 |
| | *cytherea* | (Dana) | 11 | | *pallida* | (Dana) | 63 |
| | *digitifera* | (Dana) | 12 | | cf. *speciosa* | (Dana) | 64 |
| | *humilis* | (Dana) | 13 | | sp. 1 | | 65 |
| | *stoddarti* | Pillai & Scheer | 14 | *Favites* | *abdita* | (Ellis & Solander) | 67 |
| | *austera* | (Dana) | 15 | | *halicora* | (Ehrenberg) | 68 |
| | *yongei* | Veron & Wallace | 16 | | *peresi* | Faure & Pichon | 69 |
| | *valida* | (Dana) | 17 | | *flexuosa* | (Dana) | 71 |
| | *nasuta* | (Dana) | 18 | | *pentagona* | (Esper) | 72 |
| | cf. *danai* | (Edwards & Haime) | 19 | | *chinensis* | (Verrill) | 73 |
| | *clathrata* | (Brook) | 122 | *Goniastrea* | *pectinata* | (Ehrenberg) | 74 |
| | *formosa* | (Dana) | 124 | | *edwardsi* | Chevalier | 75 |
| | cf. *nobilis* | (Dana) | 127 | *Platygyra* | *daedalea* | (Ellis & Solander) | 77 |
| | *grandis* | (Brook) | 128 | | *lamellina* | (Ehrenberg) | 78 |
| | sp. 1 | | 20 | *Leptoria* | *phrygia* | (Ellis & Solander) | 79 |
| | sp. 2 | | 123 | *Oulophyllia* | *crispa* | (Lamarck) | 80 |
| | sp. 3 | | 130 | *Hydnophora* | *exesa* | (Pallas) | 81 |
| *Montipora* | *danae* | (Edwards & Haime) | 21 | | *microconos* | (Lamarck) | 82 |
| | cf. *floweri* | Wells | 22 | *Montastrea* | *curta* | (Dana) | 83 |
| | encrusting group | | 23 | | sp. 1 | | 85 |
| | foliaceous group | | 24 | *Plesiastrea* | *versipora* | (Lamarck) | 86 |
| | *stellata* | Bernard | 126 | *Diploastrea* | *heliopora* | (Lamarck) | 87 |

| | | | |
|---|---|---|---|
| *Astreopora* | sp. 1 | | 25 |
| | sp. 2 | | 26 |
| *Pavona* | *varians* | Verrill | 37 |
| | *maldivensis* | (Gardiner) | 38 |
| | cf. *explanulata* | (Lamarck) | 39 |
| | *cactus* | (Forskal) | 40 |
| | *decussata* | (Dana) | 41 |
| | *duerdeni* | Scheer & Pillai | 42 |
| *Gardineroseris* | *planulata* | (Dana) | 43 |
| *Pachyseris* | *speciosa* | (Dana) | 44 |
| *Leptoseris* | *scabra* | Vaughan | 45 |
| | *hawaiiensis* | Vaughan | 46 |
| | *mycetoseroides* | Wells | 48 |
| | *yabei* | (Pillai & Scheer) | 49 |
| *Coscinaraea* | sp. 1 | | 50 |
| *Siderastrea* | *savignyana* | Edwards & Haime | 51 |
| *Cycloseris* | *vaughani* | (Boschma) | 52 |
| *Fungia (Fungia)* | *fungites* | (Linnaeus) | 53 |
| *F. (Danafungia)* | | | 54 |
| *F. (Verrillofungia)* | | | 55 |
| *F. (Pleuractis)* | | | 56 |
| *Herpetoglossa* | *simplex* | (Gardiner) | 57 |
| *Herpolitha* | *limax* | (Hottuyn) | 58 |
| *Podabacia* | *crustacea* | (Pallas) | 59 |
| *Porites* | *lobata/lutea* | | 27 |
| | small massives | | 28 |
| | *nigrescens* | Dana | 129 |
| *Leptastrea* | *purpurea* | (Dana) | 89 |
| | *transversa* | Klunzinger | 90 |
| | *inaequalis* | Klunzinger | 91 |
| *Cyphastrea* | *chalcidicum* | (Forskal) | 92 |
| | *microphthalma* | (Lamarck) | 93 |
| | sp. 1 (8 septa) | | 94 |
| *Echinopora* | *lamellosa* | (Esper) | 95 |
| | *gemmacea* | (Lamarck) | 96 |
| | sp. 1 | | 97 |
| *Galaxea* | *fasicularis* | (Linnaeus) | 98 |
| *Merulina* | *ampliata* | (Ellis & Solander) | 100 |
| *Blastomussa* | *merletti* | (Wells) | 101 |
| *Acanthastrea* | *echinata* | (Dana) | 103 |
| *Lobophyllia* | *hemprechii* | (Ehrenberg) | 104 |
| | *corymbosa* | (Forskal) | 105 |
| *Symphyllia* | cf. *recta* | (Dana) | 107 |
| *Echinophyllia* | *aspera* | (Ellis & Solander) | 109 |
| | *echinata* | (Saville-Kent) | 110 |
| *Oxypora* | *lacera* | (Verrill) | 111 |
| *Mycedium* | *elephantotus* | (Pallas) | 112 |
| *Plerogyra* | *sinuosa* | (Dana) | 113 |
| *Gyrosmilia* | *interrupta* | Ehrenberg | 114 |
| *Dendrophyllia* | *micrantha* | Ehrenberg | 118 |
| *Tubastraea* | *aurea* | Quoy & Gaimard | 116 |
| *Turbinaria* | spp. | | 115 |
| *Millepora* | all species | | 119 |
| *Tubipora* | *musica* | | 121 |

## B. The corals and coral assemblages

Coral cover on each reef is shown in fig. 5. Because of the varying and diminishing depth of reef slopes from north to south, cover was measured on all reefs at a standard depth of 2–4 m deep. With a few exceptions, coral cover is uniformly good, and does not correlate with the geographical gradient (Spearman's rank coefficient: -0.297, p = NS). Cover on all reefs with clear or moderately clear water ranges between approximately 30–60%. Values are much reduced on the three algal reef sites in the south and on the patch reef (site 4) which is located in a turbid embayment and which is immediately adjacent to mud flats and mangroves.

The provisional coral species list determined to date from in situ observations and from samples identified in the field is shown in tab. 2. However, this list includes a few species groups which clearly contain more than one species and which can be separated only with difficulty. This applies in particular to the genera *Porites, Montipora* and *Goniopora.* The species and groups of tab. 2 are used for all analyses.

In contrast with coral cover, the number of coral species declines towards the south. Fig. 6 shows the pattern graphically, and the southwards decline of species is significant (Spearman rank coefficient: -0.539, $p<0.01$). More highly significant, however, is the relationship between species richness and the vertical extent of the coral reefs (Spearman rank coefficient: 0.834, $p<0.01$). The depths of the reef slopes have already been shown to decline towards the south. With this decline there is likely to be a corresponding decline in the number of habitat types, and the southward fall of species richness is possibly attributible to this. From the Al Birk group of reefs southwards, there were generally less than 50 coral species or species groups recognised on each reef site examined, and this fell to less than ten on the southernmost algal reefs.

A number of coral species which are common and easily recognised on reefs in the northern and central Red Sea were not found in the southern survey area. Lists from Yanbu (SHEPPARD & SHEPPARD 1986) and from a wider range of northern reefs (ORMOND et al. 1984a) show that over 150 species of corals have been recorded recently from the northern and central Saudi Arabian Red Sea. Tab. 3 lists those species which do not appear to extend from the central Red Sea southwards into the present survey area. The left column were not found in the survey area or even on the fringing reef at Jeddah, although it is recognised that more thorough searching as well as the inclusion of reefs further offshore might reveal some of them. The right column lists those species which were found on the fringing reef at Jeddah, but not further south.

Fig. 7 shows graphically the degree to which 11 of the species or genera penetrate southwards along the coast. Only species with a clear and straightforward extinction towards the south are included; several others also disappear towards the south, but where these are uncommon or have ambiguous or sparse distributions they are not shown. Corals which clearly do disappear include four agariciid spe-

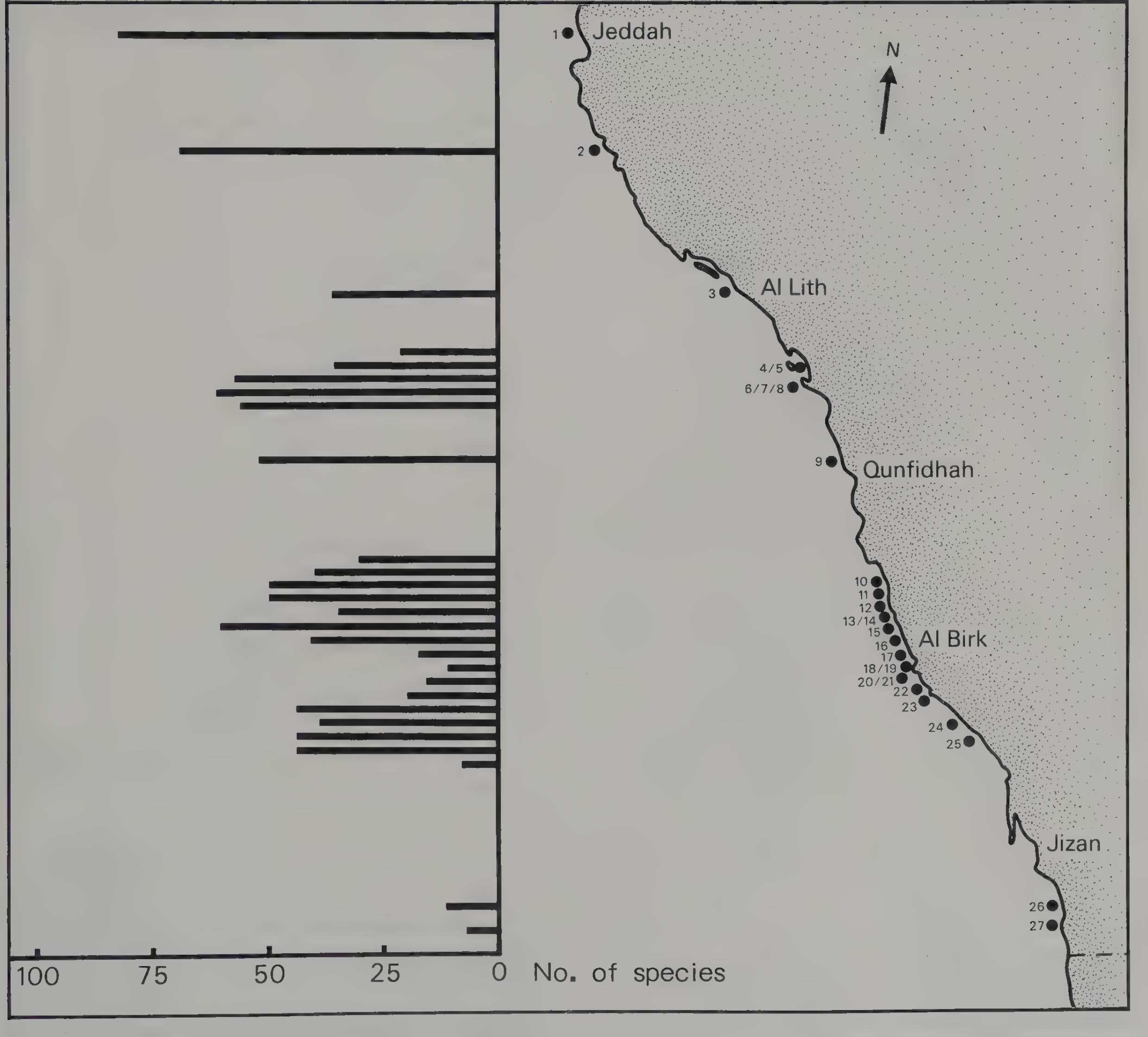


Fig. 6: Histogram of species richness on each reef slope.

**Table 3**

Coral species found in central and northern Saudi Arabia, but not found from Jeddah southwards in present survey:

*Alveopora* sp. 2
*Leptoseris tenuis*
*Favia rotumana*
*Favites rotundata*
*Gonaistrea australensis*
*Montastrea magnestellata*
*Leptastrea bottae*
*Galaxea astreata*
*Blastomussa loyae*
*Lobophyllia hattai*
*Symphyllia valanciennesii*
*Tubastraea* sp. 2
*Heliopora coerulea*

Coral species found in central and northern Saudi Arabia as far south as Jeddah, but not beyond, in present survey:

35 *Alveopora* sp. 1
38 *Pavona maldivensis*
42 *Pavona* "massive"
56 *Fungia (Pleuractis)* sp.
59 *Podabacia crustacea*
61 *Favia laxa*
101 *Blastomussa merletti*
107 *Symphyllia recta*
116 *Tubastraea* sp. 1
118 *Dendrophyllia* spp.

Species found as far south as Jeddah, and also on offshore patch reef at Ras Mahassin:

114 *Gyrosmilia interupta*

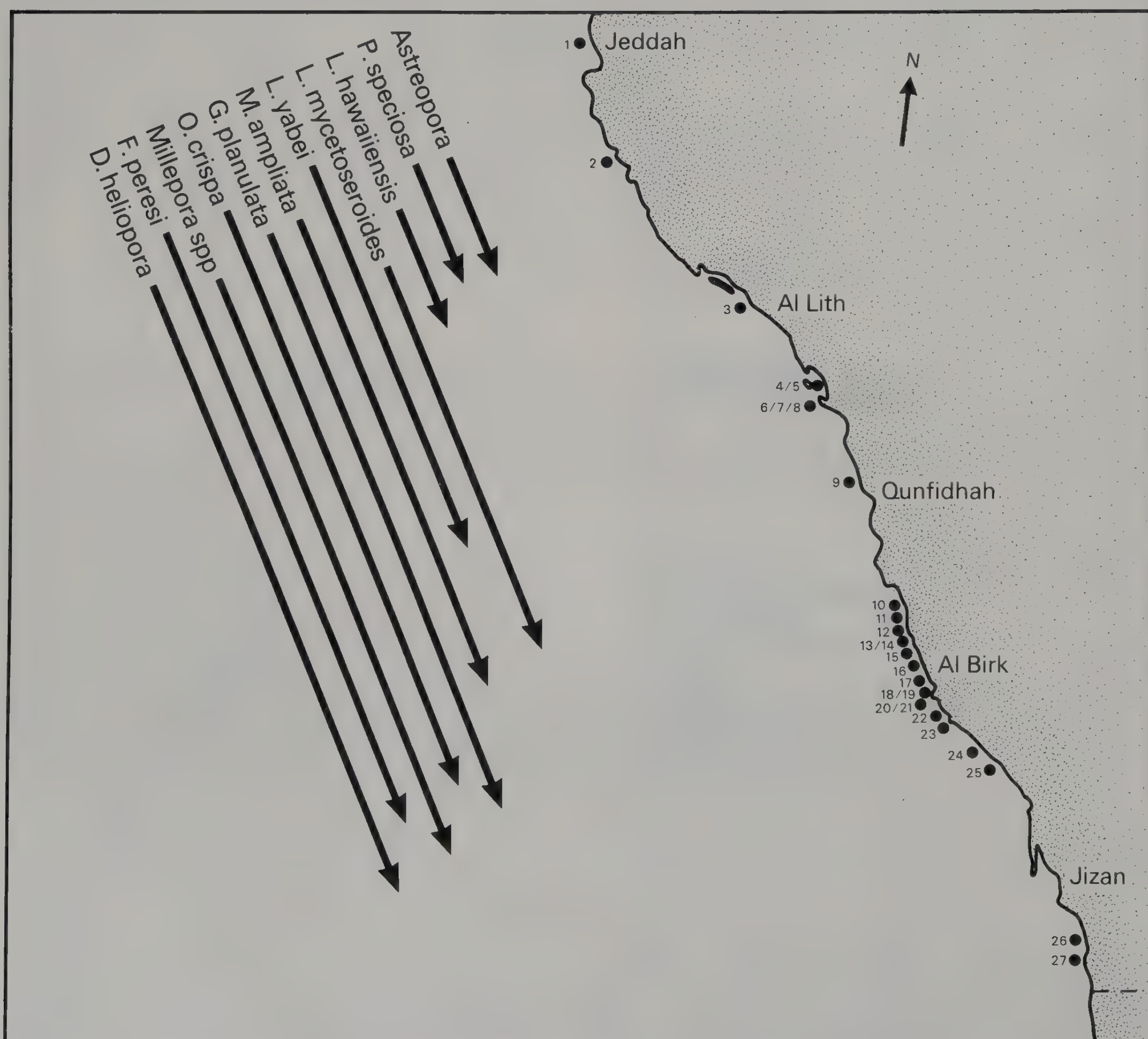


Fig. 7: Southerly extension of 11 coral species or groups which show a clear extinction pattern within the area.

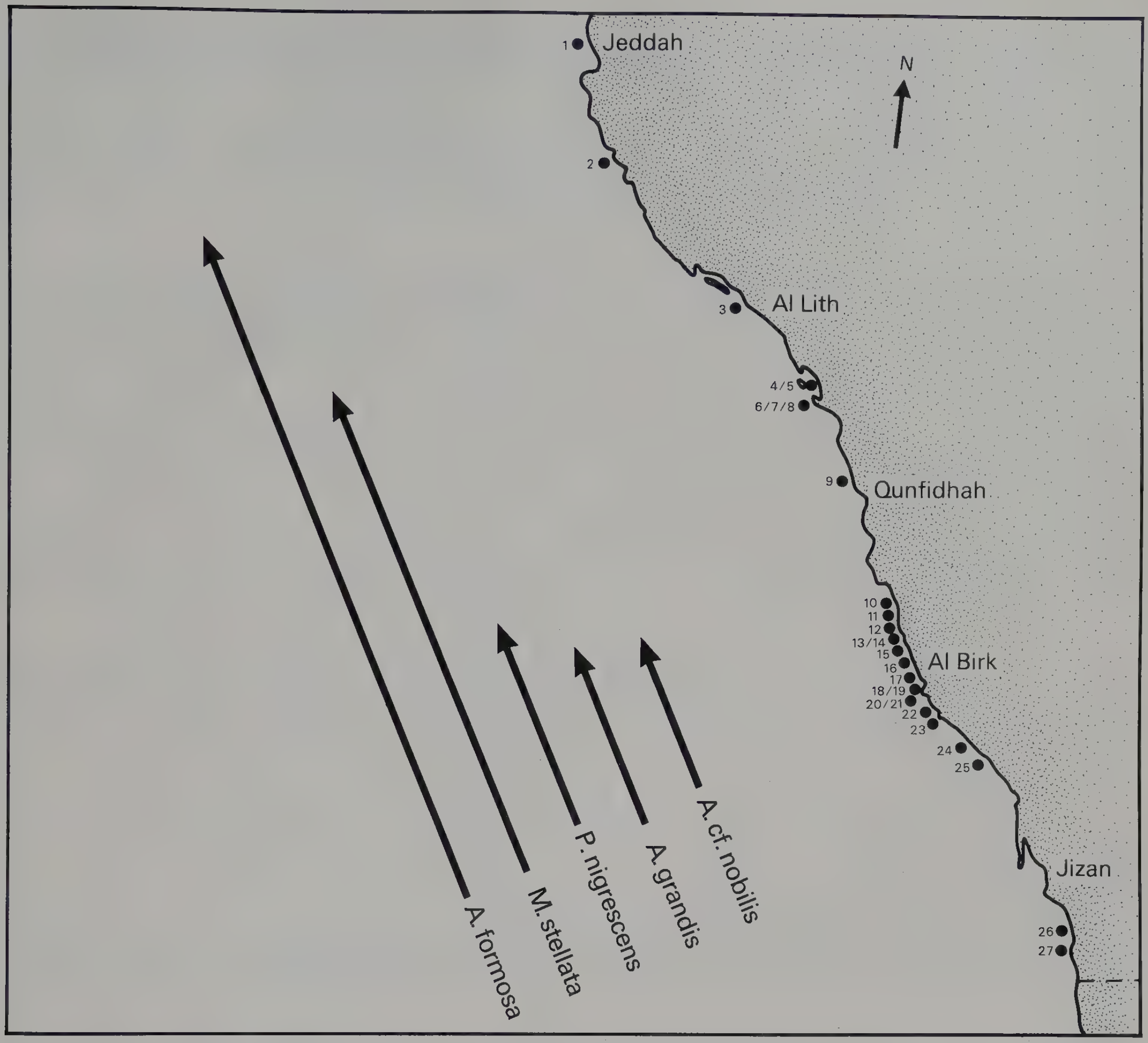


Fig. 8: Northerly extension of 5 coral species which show a clear extinction pattern within the area.

cies. These species usually occupy deeper habitats, and their disappearance is unsurprising. Of greater note is the disappearance within the survey area of the hydrozoan *Millepora.* It is common as far south as Qunfidhah, and appears as rare, bleached colonies as far down as the northern end of the Al Birk group of reefs after which it disappears altogether. Reasons for the disappearance of these species may be attributed to changes in habitat diversity and to changes in a wide range of unmeasured oceanographic parameters, most notable of which is increased sedimentation. All these species are found not only in the north of the Red Sea but also in the Indian Ocean.

A reciprocal pattern is seen with five other species (fig. 8). These species are found in the south of the survey region – but not generally on the low diversity algal reefs – and disappear towards the north. Three are species of *Acropora*, while the other two are *Porites nigrescens* and *Montipora stellata*. Perhaps significantly, all five species are branching forms. All occur widely in the Indo-Pacific Ocean, but generally were not found by Sheppard & Sheppard (1986) or by Ormond et al. (1984a) on reefs in the central or northern Saudi Arabian Red Sea, even in areas with similar degrees of turbidity and with similar bathymetry and topography. This distribution may therefore be a straightforward geographical one.

Soft coral cover, in contrast, shows a rapid decline towards the south (fig. 9). As far south as Al Lith, soft corals cover about 40% of the reef slopes at 2–4 m deep. From this point southwards, however, some reefs supported a very low cover of alcyonarians (<5%), but most supported none at all. *Xenia* is the dominant genus on the northern reefs of the survey area where soft coral is abundant, and this is also found sporadically on more southerly reefs. The soft coral genus *Dendronephthya*, which is the most conspicuous soft coral genus on northern and central reefs of the Red Sea in water down to 10 m deep, is extremely rare or absent south of Shu'aiba.

The majority of reef flats have extensive and sometimes thick covers of mud or coarser sediments and most do not form a part of the coral survey. The seaward parts of all have a small amount of exposed hard substrate, but reef flat coelenterates provide, with one exception, an insignificant cover. The reef crests are covered by calcareous red algae and *Sargassum*, as already noted. The exception is the reef flat on a patch reef off Ras Mahassin (site 7a) which measured about 500 × 200 m. This reef flat supported 8 species of corals including a massive *Porites* species. The latter grows into well developed microatolls covering a total of 20% of the surface. A total of 30% of the surface of this reef flat was colonised by corals, with most of the remaining surface being covered by a veneer of sand. A second atypical aspect of this reef flat occurs towards the seaward edge where, instead of the usual *Sargassum* zone, there exists a near complete cover of the green alga *Caulerpa*, amongst which exists large patches of zooanthids. No other reef flat provided sufficient biotic data to be included in any analyses.

As shown, the number of coral species declines steadily southwards, while simultaneously several species either appear or disappear. The trends are not smooth since the varying topography of the reefs and their differing proximity to mangroves and other areas of mud add localised variations. To take all the quantitative and qualitative factors into account and to further indentify the patterns which may exist in the coral data, the cluster analysis was performed. Fig. 10 shows the resulting dendrogram.

Six clusters of sites are distinguished at a fusion level of 0.33, where each cluster is only one third similar or at least two thirds dissimilar to each other cluster. Fig. 11 shows the spatial distribution of these 6 clusters, separated by geographical location and depth. Cluster 1 is the most distinct and comprises the three algal reefs. These three sites have very low coral diversity and cover. The corals they share are *Siderastrea* and several faviids. They share the same profile type, which is illustrated in fig. 4d. They are all located in the far south of the survey area and are encircled in fig. 11 with an unbroken line.

Cluster 2 is also small and distinctive. It includes three sites (17–19) which are closely adjacent in the middle of the long stretch of discontinuous fringing reef centred about Al Birk. In fig. 11 these three sites are encircled by an unbroken line. They are all located very near mangroves and are highly turbid. They separate out because they are highly dominated by *Porites* (species no. 125 in Appendix 1) and have no or very little *Acropora*. These also share a common profile type, which is a steep descent to a muddy floor at 5 m deep and which is illustrated in fig. 4c.

Cluster 3 has 12 sites. These are all diverse to highly diverse assemblages, without any dominant species. They include all the Jeddah, Shu'aiba and Ras Mahassin sites from about 3 m downwards to 35 m, but include shallower regions nearby where these experience very low exposure. No high exposure sites exist in this cluster. Coral cover is always moderate at best, but the absence of any dominant species ensures a good diversity of corals. Their profile is one of a moderately steep slope, the extent of which varies from 35 m deep at Jeddah to only 4 m deep in the sheltered patch reefs of sites 4 and 5. They are illustrated in the general profile in fig. 4a. A notable feature of these coral assemblages is that they are only found in the northern part of the survey area, where they are shown encircled by a dashed line.

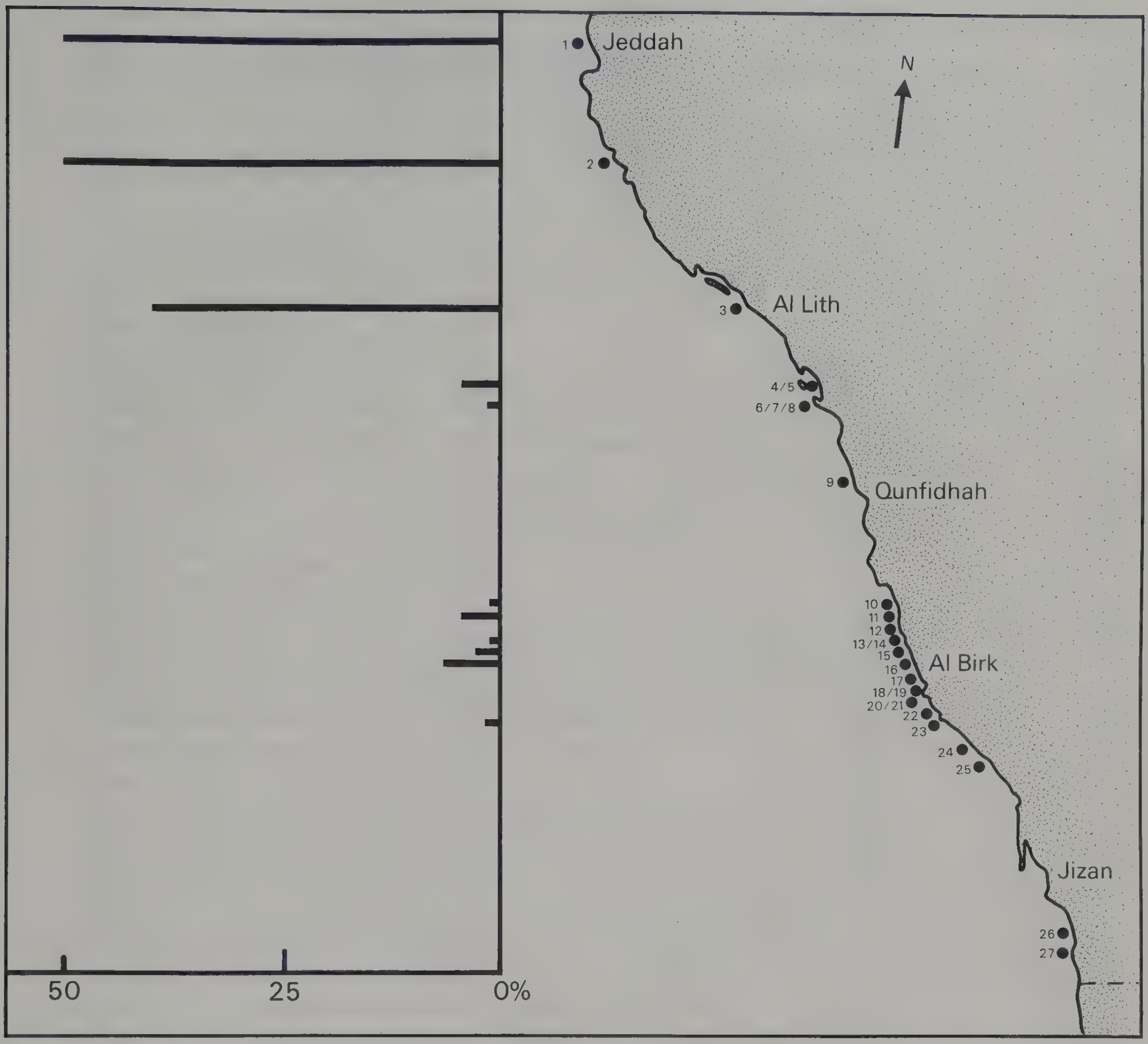


Fig. 9: Histogram of soft coral cover (%) on each reef slope at 2–4 m deep.

Cluster 4 consists of eight sites. They share a high diversity, but unlike those of cluster 3 they have an appreciable cover of *Porites* (species no. 28), and many also share abundant *Echinopora lamellosa.* Their geographical distribution is also notable. They all occur in the central area and are shown in fig. 11 encircled by a dotted line. This region is a transition area where many of the species disappear. This distinctive cluster derives in part from the presence and absence of a miscellany of relatively minor species components, which separates it from clusters to the north and south of the survey area.

Cluster 5 is the moderately wave exposed cluster, consisting of a reduced coral diversity but dominated by the *Acropora* species *A. hyacinthus* and *A. austera* and by *Pocillopora* spp. In the extensive fringing reef around Al Birk, these are joined by the conspicuous corals *A. nobilis, A. grandis* and *A. formosa* which were locally abundant on occasion. This cluster occurs over the widest range in the survey area, and extends northwards into shallow water at Jeddah and Shu'aiba (but without the last three *Acropora* species). It is commonest, however, in the shallow regions of the long fringing reef centred about Al Birk, where it is almost universal in shallow water, except where the muddy *Porites* reef cluster intrudes.

Cluster 6 is the companion to cluster 5 on the Al Birk fringing reef. Sites in this grouping occur deeper than the latter, where there is usually a slight steepening of the slope and where tabular *Acropora*

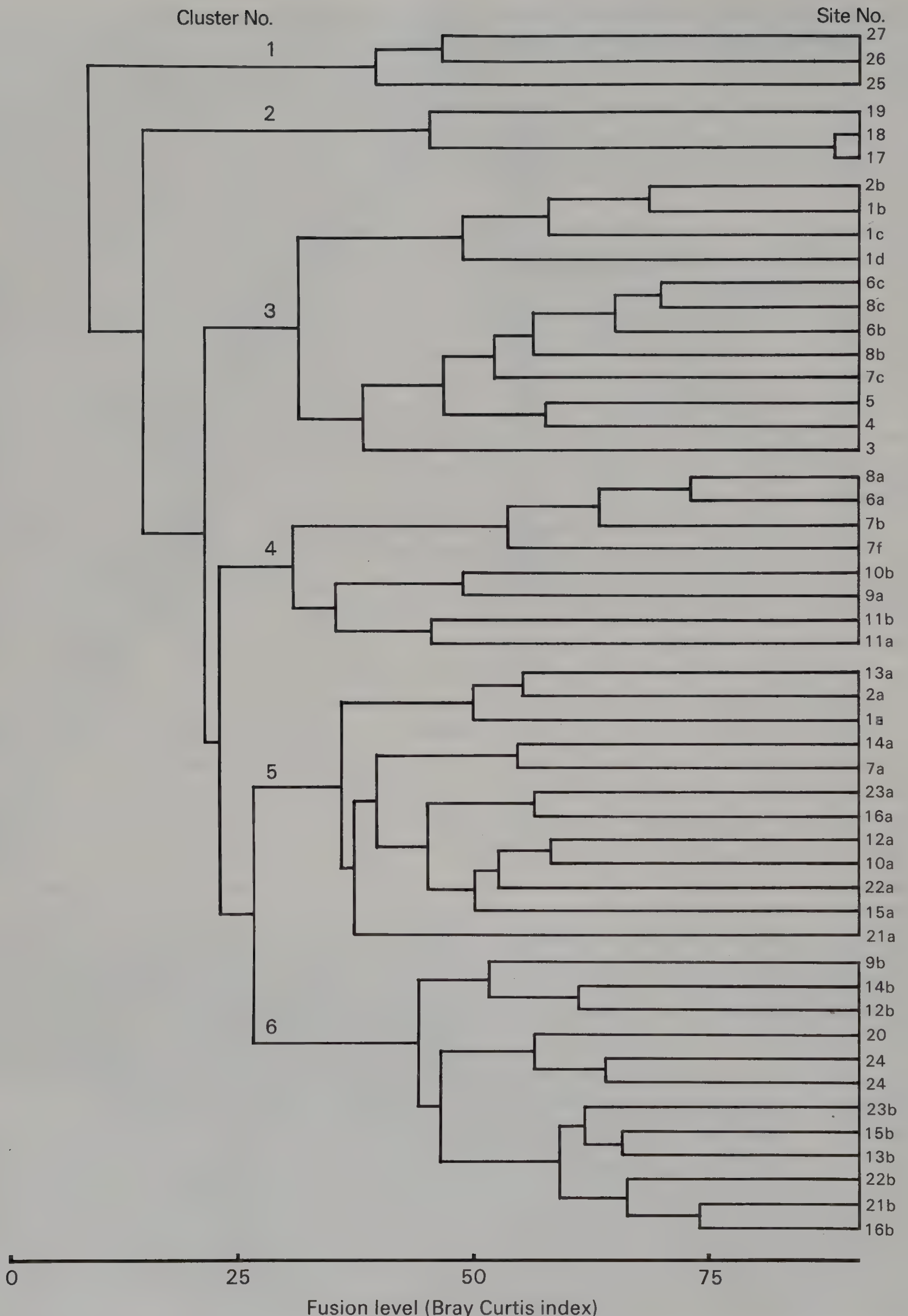


Fig. 10: Dendrogram resulting from the cluster analysis. The right hand vertical axis names each site; details of each site can be seen in Appendix 1.

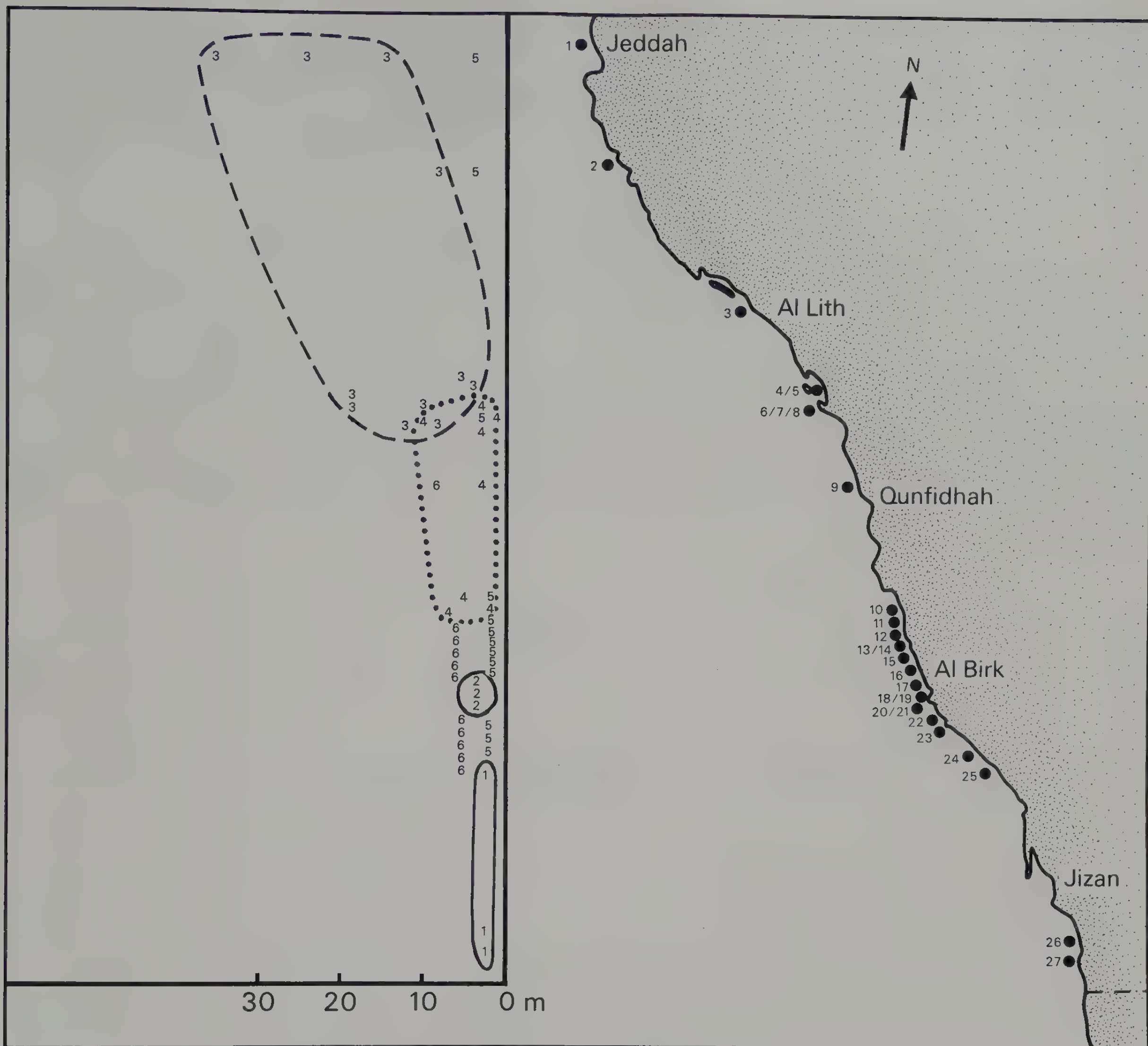


Fig. 11: The spatial distribution of each of the 6 clusters. Small numbers show position by geographical location and depth of each of the 50 sites. All sites in clusters 1 to 4 are encircled by broken or unbroken lines. For clarity, clusters 5 and 6 are not similarly encircled.

species and large, massive *Porites* (species no. 27) dominates. Reefs which support the coral assemblages of clusters 5 and 6 were the most frequently encountered in the survey area, and both dominate the discontinuous, shallow fringing reef centred on Al Birk. Their co-occurrence on this reef is clear in fig. 11. Where they occur together, these two clusters occur on the reef whose profile is shown in fig. 4b.

## DISCUSSION

This survey area is the part of the Saudi Arabian coastline which was called biogeographical subzone 4 by Ormond et al. (1984a). From the foregoing, several trends are evident within this region. There are marked differences in the extent of the reefs, the type of reef and in the coral communities upon them. The reefs themselves diminish southwards until only rudimentary reefs of calcareous red algae are left, and several coral species, soft corals and *Millepora,* all disappear at some point along this

coast. From these distributions and from fig. 11 which shows the distribution of coral assemblages on the reefs, it may be concluded that this region may be divided into four components. The first is the northern area, from Jeddah to Ras Mahassin. The second extends south from Ras Mahassin to Raka (site 11). The third continues south from there to the region of Shuqaiq, while the fourth covers the area of sparse algal reefs from Shuqaiq southwards. Each of these extends over 100–200 km of coast, and the change from one to another is always fairly abrupt.

Therefore, while the above does not invalidate the original sub-zone designation, it is important to recognise that a finer resolution divides this area further into fairly discrete components. By using these components, the place of the southern Saudi Arabian reefs in the Red Sea can be seen in perspective.

Two other parts of the Red Sea have been examined with a similar technique: the first in the Gulf of Aqaba (Loya 1972) and the second in Yanbu on the central Saudi Arabian coast (Sheppard & Sheppard 1986). In the Gulf of Aqaba, a comparible number of coral communities was distinguished by cluster analysis. At the same fusion level of 0.33, about five clusters existed, and although the nature of several of them differs from those of the southern Saudi Arabian coast, the overall number of coral species and number of coral assemblages is roughly comparible.

In contrast, the reefs of Yanbu have 13 clusters when divided at the same level. From the central Red Sea region, therefore, the number of coral assemblages falls towards the south to less than half. Three or four of the southern clusters exist, or at least have clearly similar counterparts, in the Yanbu reef complex, leaving only the *Porites* assemblage found on three very turbid reefs (sites 17–19) and the algal reefs as clearly separate.

Although there is an apparent and substantial reduction of different coral assemblages in the south when compared with the central Red Sea, the present survey only included fringing reefs and inshore patch reefs, while the Yanbu survey included many offshore reefs. The latter were not accessible in the present survey so that additional community types which may occur there remain unsampled. Recent work by Ormond et al. (1984a) suggests that some rich coral reefs occur on the Farasan bank, but their nature in terms of community classification remains unknown. From descriptions of these reefs as well as from details of the apparently similar Dahlak Archipelago (Wainwright 1965, Civitelli & Matteucci 1980, Angelucci et al. 1981), more community types may be expected. The latter in fact recognised four assemblages: a *Stylophora* and calcareous algal group, an *Acropora, Lobophyllia* group, a *Porites* group and a “sparse corals assemblage”. At least two of these appear to coincide with groups determined on the southern Saudi Arabian coast, and even with the addition of the rest it is likely that the number of different coral assemblages is substantially reduced in the south when compared with the central and northern Red Sea coast of Saudi Arabia.

The rich reef resources of Saudi Arabia, therefore, are generally not found in the south, at least in inshore and fringing areas. Reef development is discontinuous, and soft substrate ecosystems assume a greater quantitative importance. The present report does not, however, attempt to discuss the possible importance of the southern reefs in economic terms or as reproductive reservoirs for important ecological or commercial species. In general terms, the impression gained is of a gradual southwards diminution of coral reefs, both in quality and quantity, corresponding with an increasing quality and quantity of soft substrate ecosystems. But it is emphasised that the general biotic links that exist between these reefs and the soft substrate communities, which are much more extensive in this area than in the north, have not been evaluated. The importance of the reefs in the southern Red Sea should not be discounted on the basis that reefs further north are in some way better.

While this represents an evaluation of the southern fringing and inshore reefs of Saudi Arabia, it is important to state in conclusion that these form only one part of the total reef structure of the south-

ern Red Sea. Comparative work on the Saudi Arabian offshore reefs of the south has not been done to date, and almost no quantitative record at all exists for reefs of the Farasan and Dahlak Archipelagoes or of the African mainland opposite the region described here. In view of the enclosed nature of the Red Sea, such areas undoubtedly interact with the present area.

## ACKNOWLEDGEMENTS

This work was carried out as part of Phase VII of a survey of the marine and coastal habitats of the Saudi Arabian Red Sea, undertaken by the Meteorology and Environmental Protection Administration of the Kingdom of Saudi Arabia with the assistance of the International Union for the Conservation of Nature and natural Resources (IUCN) and the Tropical Marine Research Unit (TMRU), University of York. I would like to thank the Director, Dr. Rupert Ormond and members of TMRU, in particular the field organiser Dr. Alec Dawson-Shepherd for unflagging help in the field. For taxonomic help I thank A. L. S. Sheppard.

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## Appendix 1: Sites examined

1. Jeddah, North Corniche. Sites: 1a: 1.5–3 m, 1b: 3–10 m, 1c: 10–25 m, 1d: 28–35 m.

Description: Reef flat about 75 m broad, extending to 10 m wide strip of *Sargassum*. Shallowest zone (1a) extends at about 10° from bottom of green algal dominated "2 metre terrace" down to beginning of drop-off. Next zone (1b) encompasses the steep (60–90°) drop-off to its foot at 10 m deep. The deepest two zones are somewhat arbitrarily divided. Site 1c is the shallower part of the reef slope from the foot of the steep (45°) drop-off to 25 m. Site 1d continues at the same incline from 28 m to soft substrate at 35 m deep.

2. Shu'aiba. Sites: 2a: 1–3 m, 2b: 3–10 m.

Description: Reef flat almost 200 m broad, extending to reef edge with patchy red algae and little *Sargassum*. Shallowest 1 m is dominated by green algae. The shallowest zone (2a) extends from the green algae zone to 3 m with a slope of up to 30°, and is *Acropora* dominated. The steeper slope (45°) from this to soft substrate at 10 m (site 2b) is dominated by soft corals, notably *Xenia*. Area is sedimented, and lies 300–500 m behind an offshore patch which does not reach the surface.

3. Al Lith. Site: 3: 0–3 m.

Description: Narrow reef flat (40 m) leading to belt of *Sargassum*. Reef slope is very sedimented, and extends at 30° to 3 or 4 m deep where there is fine, calcareous silt. Shallower part has high cover of corals and soft corals. Deeper part is dominated by the coral *Galaxea fasicularis*.

4. Mangrove island in Ras Mahassin Bay. Site: 4: 0–3.5 m.

Description: Mangrove covered mud bank in bay, bordered to seaward (north and west) by 70 m wide reef flat. Reef edge is covered in *Sargassum* and *Turbinaria*. The slope is 45° and has low coral cover. Mud at 3.5 m.

5. Patch reef in Ras Mahassin Bay. Site: 5: 0–2m.

Description: Patch reef 200 m from shore near mouth of Ras Mahassin Bay. Northwest side had moderate coral cover on 45° slope to 2 m deep.

6. Ras Mahassin fringing reef. Sites: 6a: 1.5–4 m, 6b: 5–8 m, 6c: 10–13 m.

Description: 200 m wide reef flat leading to dense *Sargassum* belt. Shallowest site (6a) slopes at 20° to drop-off; middle site (6b) continued at about 45° to 8 m, while the deepest site (6c) extends from 10 m to sand at 15 m with a slope of about 30°. Coral cover is 30–50% throughout, soft corals <5%.

7. Offshore patch reef, Ras Mahassin, seaward slope. Sites: 7f: reef flat 0 m, 7a: 0–1 m, 7b: 1–5 m, 7c: 7–14 m.

Description: Reef flat differed from those of all fringing reefs by having coral cover of 20%. Seaward edge of flat also unique by having a 10 m wide belt entirely covered with the green alga *Caulerpa*. Shallowest site (7a) sloped at 5°. The slope then steepens gradually to 30° and is arbitrarily divided into 7b and 7c about the mid depth.

8. Offshore patch reef, Ras Mahassin, back reef slope. Sites: 8a: 0–2 m, 8b: 2–5 m, 8c: 5–10 m.

Description: This is the only shoreward facing reef slope of the survey. Site 8a extends at to the drop-off at 2 m deep. The two deeper sites are an arbitrary division of a continuous slope of 45° to 10 m deep, where sand is reached.

9. 6 km north of Qunfidhah. Sites: 9a: 0–3 m, 9b: 4–7 m.

Description: Reef slope is more or less constant at 35–45° from the *Sargassum* belt to sand at 7 m deep. The division of the slope into two sites occurs about the mid point. The deeper part (9b) is dominated by foliaceous corals.

10. Raka fringing reef. Sites: 10a: 1–2 m, 10b: 2–4 m.

Description: A broad reef flat extends to a dense *Sargassum* strip at its seaward edge. From there,

the reef slopes at <5° to 2 m deep, forming site 10a. A steeper slope (30°) to sand at 4 m provides the location of site 10b. Coral cover increases from 35 to 65% with increasing depth.

11. Fringing reef between Raka and Kor Amiq. Sites: 11a: 1–2 m, 11b: 2–7 m.

Description: A reef flat extends out about 120 m to a dense *Sargassum* belt at its seaward edge. On the reef slope, no drop-off exists. The slope is <5° to 2 m (site 11a), at which point it steepens (>5°) and encompasses site 11b. Coral cover decreases with increasing depth.

12. Fringing reef near Kor Amiq, 5 km south of site 11. Sites: 12a: 2–3 m, 12b: 3–5 m.

Description: The reef flat is about 100 m wide with a dense *Sargassum* strip at its seaward edge. From there, the reef slopes at <5° to 2 m (site 12a) and then steepens to 20° (site 12b). Coral cover increases from 20% immediately below a *Sargassum* belt, to 60% at 5 m, from which point sand extends horizontally.

13. Lava outcrop, 10 km south of site 11. Sites: 13a: 0.5–2 m, 13b: 2–4 m.

Description: There is no reef flat in this region for a stretch of about 400 m where a lava flow reaches the shoreline. Instead, hard substrate commences to slope downwards directly from the shoreline. There is minimal *Sargassum*, and a high coral cover reaching 70% at 4 m deep. The substrate slopes very gently (<2°) to 2 m (site 13a), and then at 5° from 2–4 m deep (site 13b).

14. Fringing reef 0.5 km south of the lava outcrop at site 13. Sites: 14a: 1.5–3 m, 14b: 3–5 m.

Description: This fringing reef extends for no more than 2 km, from the lava outcrop 0.5 km north, to mangroves in the south. The reef flat is 150 m wide, leading to a dense *Sargassum* belt. From there to 3 m the slope is <3° supporting a high cover of *Acropora*. This forms site 14a. The reef from 3 m slopes at about 20° and supports a 70% coral cover (site 14b).

15. Fringing reef 25 km south of Kor Amiq. Sites: 15a: 1–2 m, 15b: 2–5 m.

Description: The reef fringes a small promentory and is bounded to north and south by mangroves. The reef flat extends out to a dense *Sargassum* belt.

16. Fringing reef 8 km north of Al Birk. Sites: 16a: 1–2 m, 16b: 2–5 m.

Description: A short stretch of fringing reef bounded to north and south by mangroves. A 120 m wide reef flat leads to a dense *Sargassum* belt. Site 16a covers the gently decending (<5°) reef slope from 1 m deep to a point where the slope steepens. From there to 5 m the reef slopes at over 10° and supports a high coral cover. This section is site 16b.

17. Fringing reef 3 km south of Al Birk. Site: 17: 0–5 m.

Description: A short stretch of fringing reefs bounded by mangroves. The reef flat extends 150 m from the shore, the inner part being covered with mud, grading to hard substrate near the dense *Sargassum* belt. Seaward of this algae, the reef slopes irregularly at 45–90° down to mud at 5 m deep and is dominated by *Porites*. No subdivision of this slope was made.

18. Fringing reef 10 km south of Al Birk. Site: 18: 0–5 m.

Description: One kilometre of fringing reef bounded to north and south by mangroves. Reef flat is 50 m wide, with a narrow but dense *Sargassum* belt. From the latter, the reef drops steeply (60°) to fine silt at 5 m. The reef is not divided into different sites. *Porites* dominates the reef, which is very sedimented.

19. Fringing reef 1 km north of Al Qurma. Site: 19: 0.5–4 m.

Description: Reef flat is 100 m wide, leading to dense *Sargassum* belt. From there, the reef drops steeply or vertically to fine silt at 5 m and is not subdivided. The reef is very sedimented and dominated by *Porites*.

20. Patch reef off Al Qurma. Site: 20: 0.5–4 m.

Description: Patch reef lies in a large bay, at least 1 km from mainland to north and south. The reef slopes at 45–90° down from a *Sargassum* belt, and is moderately sedimented and dominated by

*Porites.* The substrate becomes muddy at 4 m deep. The reef is not subdivided.

21. Fringing reef at Al Qurma. Sites: 21a: 1–2 m, 21b: 2.5–5 m.

Description: Reef flat is 150 m broad, ending at a dense *Sargassum* belt 20 m wide. A wide expanse of smoothly sloping reef (10°) extends for over 100 m from the low water level to 5 m deep, and this is arbitrarily divided into two sites about the mid point. Large *Porites* boulders and *Acropora* tables are abundant over the deeper part.

22. Fringing reef opposite Quadimbal Island. Sites: 22a: 1.5–3 m, 22b: 3–5 m.

Description: Reef flat is 150 m wide leading to a *Sargassum* belt. Site 22a encompasses the shallower part which slopes at <5°, while site 22b includes the reef from 3–5 m deep which slopes a little more steeply at over 5°.

23. Fringing reef 25 km south of Al Qurma. Sites: 23a: 2–3 m, 23b: 3–5 m.

Description: A 50 m wide reef flat, bordered by *Sargassum* over 2 m tall. Site 23a extends from the base of this at 2 m deep to 3 m, over a near horizontal substrate dominated by *Acropora.* From 3 m, site 23b drops at a slightly steeper slope (15°) to sand at 5 m deep.

24. Patch reef near Ras al Abyad. Site: 24: 2–5 m.

Description: Large patch reef (1×3 km) 2 km seaward of Ras al Abyad, south of Shuqaiq. The top is extensively covered with *Sargassum* and sandy patches. The seaward slope of this drops irregularly to 5 m with no clear topographical changes, so the site is not divided. Two sets of records were obtained, separated by about 1 km. The reef is sedimented, but supports a high diversity of corals.

25. Patch reef, Bubel Abyad. Site: 25: 0–3 m.

Description: This patch reef is about 500 m offshore and 150 m in diameter. It consists of the shallowest reef zone only, namely the zone of red, calcareous algae covered with dense *Sargassum.* No reef slope deeper than this exists, and corals provided <1% cover.

26. Fringing reef near Khor al Wahla. Site: 26: 0–3 m.

Description: The fringing reef is 120 m broad, leading to a dense but narrow fringe of *Sargassum.* Offshore are numerous additional patches of *Sargassum* scattered over the horizontal sandy substrate which lies at 2–3 m deep. Each patch consists of the shallowest reef zone only, namely the zone of red, calcareous algae covered with dense *Sargassum.* No reef slope deeper than this exists. Corals are very sparse (<1%), although *Siderastrea* is relatively abundant.

27. Patch reef 10 km south of Khor al Wahla. Site: 27: 0–3 m.

Description: The patch reef is 100 m offshore and consists of the shallowest reef zone only, namely the zone of red, calcareous algae covered with dense *Sargassum.* No reef slope deeper than this exists. Corals are very sparse (<1%), but *Siderastrea* is relatively abundant.

# Marine Tubificidae (Oligochaeta) of the Arabian Gulf Coast of Saudi Arabia (Part 2)

**C. Erséus**

Abstract: *Olavius manifae* n. sp. and *O. verpa* n. sp. from shallow-water subtidal localities at the North-east coast of Saudi Arabia are described. Both species are devoid of an alimentary canal. The first species is distinguished from its congeners by its possession of numerous penial setae (7 – 9 per bundle), which are arranged in fan-shaped bundles. The second species lacks penial setae but has well developed protrusible penes. A new record of *Limnodriloides appendiculatus* Pierantoni, 1903, previously known only from the Mediterranean Sea, is given.

Keywords: Oligochaeta, marine Tubificidae, Arabian Gulf, taxonomy.

الديدان الأنبوبية البحرية (Oligochaeta) في
شواطئ الخليج العربي للمملكة العربية السعودية
(الجزء الثاني)

سي . ارسا يوس

خلاصة : تم وصف النوعين الجديدين Olavius manifae و O. verpa من المياه الضحلة من شمال شرق شواطئ الخليج العربي للمملكة العربية السعودية . ويفتقد النوعين الجديدين الى قناه هضمية . ويختلف النوع الأول عن أشباهه بامتلاكه اشواك قضيبية عديدة (٧ – ٩ في كل حزمه) ، مشكلة حزم مروحية الشكل . ويفتقد النوع الثاني الاشواك القضيبية ولكنه مزود بقضيب متطور قابل للانثناء والبروز . كذلك تم تسجيل النوع Limnodriloides appendiculatus المعروف سابقا في البحر الأبيض المتوسط فقط .

## INTRODUCTION

In a recent taxonomic revision of the gutless members of the Phallodrilinae, a marine subfamily within the oligochaete family Tubificidae, 38 species from various tropical and subtropical parts of the world were considered (Erséus 1984). Many of these species had previously been regarded as congeneric to "normal", gut-bearing relatives (*Phallodrilus* Pierantoni and *Coralliodrilus* Erséus), but in the revision it was concluded that the gutless Phallodrilinae constitute a monophyletic group which has deviated considerably from the rest of the subfamily, so as to deserve the status of at least generic rank. Consequently, each of the 38 species was assigned to either of two exclusively gutless genera, *Inanidrilus* Erséus, 1979 and *Olavius* Erséus, 1984. The ultrastructure and ecology of one of these species have been reviewed by Giere et al. (1984).

To date, only one gutless species, *Olavius comorensis* (Erséus, 1981) from the Comoro Islands, has been known from the Indian Ocean, although several such species are described from the South Pacific (Erséus 1981, 1984). However, in material received for identification from the Arabian Gulf Coast of

Saudi Arabia, the author encountered two new species of *Olavius*, which are described below. In addition, *Limnodriloides appendiculatus* Pierantoni, 1903 (subfamily Limnodriloidinae), previously known only from the Mediterranean Sea, is recorded from the Arabian coast.

The present paper is a continuation of a study of Arabian Gulf marine Tubificidae (Erséus 1985) in which fourteen species, nine of which new to science, were described.

## MATERIAL AND METHODS

*Olavius manifae* n. sp. and *Limnodriloides appendiculatus* were found in samples of the "Northern Area Biological Study (1984)" (University of Petroleum & Minerals, Dhahran; principal investigator J. C. McCain) along the northern part of the Arabian Gulf coast of Saudi Arabia. The worms were stained in paracarmine and mounted whole in Canada balsam by the present author.

The specimens of *O. verpa* n. sp. were found in material collected earlier (1982) in the same area in connection with a baseline marine study undertaken by the Arabian American Oil Company (principal investigator J. C. McCain). This material was placed at my disposal by E.V.S. Consultants Ltd. (Sidney, B.C., Canada), and it originated from an identification contract for the Saudi Arabian Tetra Tech, Inc. (Dhahran). These worms had been stained in alcoholic borax carmine, mounted and identified as a new gutless species by the late Dr. H. R. Baker (University of Victoria, B. C., Canada), but they were never described by him.

The type series of the new species are deposited in the Swedish Museum of Natural History (SMNH), Stockholm. Other material is retained in the present author's collection.

Length ranges given in the descriptions refer to the fixed material, ranges of diameter to segment XI (clitellar region) of the whole-mounted, slightly compressed individuals.

Abbreviations used in the text: spm/spms: specimen/specimens; whm: whole-mounted.

Abbreviations used in the figures:

a - atrium
aa - atrial ampulla
ad - atrial duct
cs - copulatory sac
p - penis
pp - pseudopenis
ppa - prostatic pad
pr - prostate gland
pr 1 - anterior prostate gland
pr 2 - posterior prostate gland
ps - penial seta
s - spermatheca
sz - spermatozeugma
vd - vas deferens

## DESCRIPTIONS

Subfam. **Phallodrilinae**

***Olavius*** Erséus, 1984

***Olavius manifae*** n. sp. (fig. 1)

Holotype: whm spm, Saudi Arabia: off the town Manifa, seagrass bed near coral reef, subtidal, 3 m, 27.V.1984, SMNH 3340 (part). – Paratypes: 2 whm spms, type locality, SMNH 3340 (part). – Author's collection: 4 whm spms, type locality.

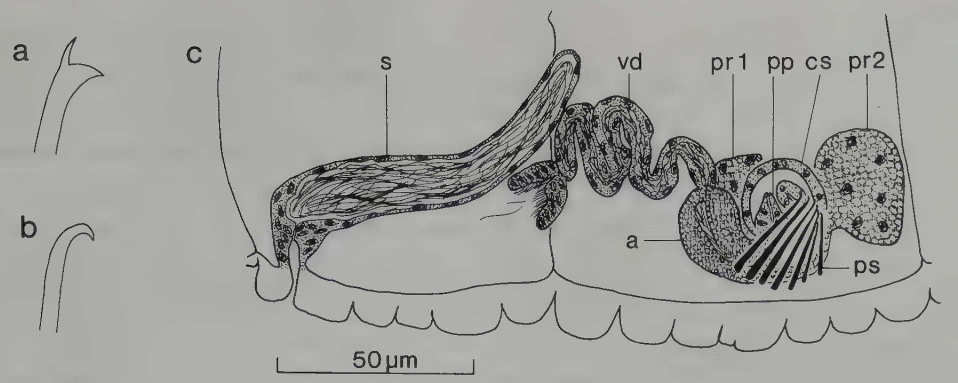


Fig. 1: *Olavius manifae* n. sp.: a, Free-hand drawing of seta. b, Free-hand drawing of penial seta. c, Somewhat horizontal view of spermatheca and male duct in segments X–XI.

Description: Length 3.7–5.1 mm, 41–49 segments. Diameter 0.11–0.14 mm. Clitellum extending over ½X–XII when fully developed. Secondary annuli conspicuous, 7 per (postclitellar) segment. Pygidium elongate and tapering, with rounded apex. Somatic setae (fig. 1a) small, bifid, with upper tooth thinner and slightly shorter than lower; subdental ligament absent. Bifids 25–30 µm long, about 1 µm thick, 2 per bundle throughout body. Penial setae (fig. 1c, ps) numerous, in fan-shaped bundles (ectal tips close together, ental ends spread out) in walls of copulatory sacs. Penials about 7–9 per bundle (exact numbers – they clearly vary somewhat – difficult to establish), about 25 µm long, 1–2 µm thick, with single-pointed, curved tips (fig. 1b). Male pores paired in line with ventral somatic setae, posteriorly in XI. Spermathecal pores paired in line with dorsal setae, anteriorly in X.

Male genitalia (fig. 1c) paired. Vas deferens 4–6 µm wide, much longer than atrium, lacking (or with very thin?) muscular lining, appear to enter atrium more or less apically. Atrium comma-shaped, about 40 µm long, 12–15 µm wide, with very thin outer lining and inner granulated epithelium. Anterior prostate gland attached to atrium near entrance of vas deferens. Posterior prostate gland attached by long, inconspicuous stalk to dorsal face of ectal part of atrium. Atrium ectally tapering and opening at middle (?) of small pseudopenial papilla located within a moderately developed copulatory sac; latter with somewhat folded walls. Spermathecae (fig. 1c, s) filiform, consisting of very short, indistinct ducts and slender, thin-walled ampullae; latter 70–110 µm long, 11–19 µm wide (always somewhat wider ectally than entally), and containing loose bundle of sperm in postcopulatory spms.

Remarks: Few species within *Olavius* have multiple (more than 3 per bundle) penial setae; *O. clavatus* (Erséus, 1981) has 5 such setae per bundle, *O. filithecatus* (Erséus, 1981) 7, and *O. manifae* n. sp. about 7–9. The new species is, however, easily distinguished from the other two (both Great Barrier Reef forms) by the fan-shaped arrangement of the penial setae (setae parallel within bundle in *clavatus* and *filithecatus*). *Olavius manifae* is further distinguished from *O. clavatus* by the lack of a very large papilla (separated from the atrial opening) in its copulatory sacs (such a papilla is present in *clavatus*; Erséus 1981: fig. 10), and its slender, non-muscular spermathecal ampullae (these ampullae club-shaped and muscular in *clavatus*); and from *O. filithecatus* by its consistently bisetal bundles throughout the body (anterior bundles often trisetal in *filithecatus*), and its non-muscular atria and vasa deferentia (atria and vasa muscular in *filithecatus*).

The spermathecae and atria of *O. manifae* are reminiscent of those of *O. albidus* (Jamieson, 1977), a third form from the Great Barrier Reef, but the latter species generally has only 3 (parallel) penial setae per bundle (cf. Erséus 1981: fig. 4), but up to 4 bifid setae in anterior segments.

Distribution and habitat: Known only from off Manifa, Arabian Gulf Coast of Saudi Arabia. Subtidal.

***Olavius verpa*** n. sp. (fig. 2)

Holotype: whm spm, Saudi Arabia: off Bandar al Mishab, between rock pile and Mishab in small embayment N of Bander al Mishab rocks, seagrass bed, subtidal. 2.5 m, 9.III.1982, SMNH 3341. – Paratypes: 2 whm spms, type locality, IV. 1982, SMNH 3342. – Author's collection: 3 whm spms, type locality, IV. 1982; 1 whm spm, Saudi Arabia: off the town Manifa, subtidal sand near coral reef, V. 1982.

Description: Length 10.1–11.8 mm, 61–68 segments. Diameter 0.11–0.16 mm. Clitellum extending over ½X–½XII. Secondary annuli conspicuous, 7 per (postclitellar) segment. Pygidium more or less tapering, with rounded apex. Setae (fig. 2a) small, bifid, with upper tooth thinner and (anteriorly) slightly shorter than, or (posteriorly) distinctly shorter than, lower tooth; subdental ligament absent. Bifids 25–30 µm long, 1–2 µm thick, 2 per bundle throughout body. Penial setae absent. Male pores paired in line with ventral setae, posteriorly in XI. Spermathecal pores paired in line with dorsal setae, anteriorly in X.

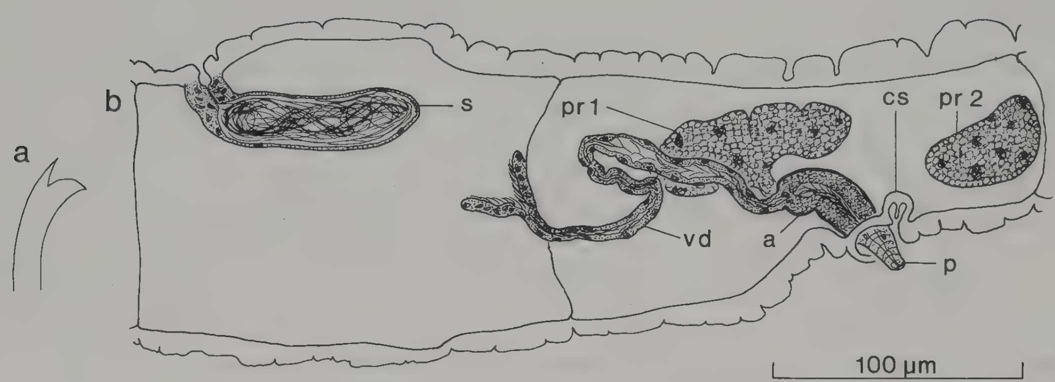


Fig. 2: *Olavius verpa* n. sp.: a, Free-hand drawing of seta. b, Lateral view of spermatheca and male duct in segments X–XI.

Male genitalia (fig. 2b) paired. Vas deferens 5–14 µm wide (widest at middle), much longer than atrium, lacking (or with very thin?) muscular lining, entering apical end of atrium. Atrium comma-shaped, about 40–45 µm long, 15–25 µm wide, with 1–2 µm thick outer lining of muscles, and ciliated and granulated inner epithelium. Anterior prostate gland attached to atrium near entrance of vas deferens. Posterior prostate gland located posterior to and well separated from atrium, but attachment with atrium not observed. Atrium ectally terminating in somewhat tapering (basically cylindrical) penis, 20–25 µm long. When not protruded (as in fig. 2b), penis enclosed in a moderately developed copulatory sac; latter with somewhat folded wall. Spermathecae (fig. 2b, s) oblong, consisting of short, cylindrical ducts and very thin-walled ampullae; latter 65–95 µm long, 20–37 µm wide, and containing random mass of sperm in postcopulatory spms.

Remarks: *Olavius verpa* n. sp. appears closely related to *O. manifae* n. sp., and its penes ("verpa" is Latin for penis) are probably, in evolutionary terms, just an elaboration of the small pseudopenial papillae present in the other species. In addition to this difference, which is not always so obvious when the penes are retained within the copulatory sacs, *O. verpa* is distinguished from *O. manifae* by its larger size, its lack of penial setae, its muscular atria and its less slender spermathecae.

Distribution and habitat: Known only from the Arabian Gulf Coast of Saudi Arabia. Subtidal.

## Subfam. **Limnodriloidinae**

### ***Limnodriloides*** Pierantoni, 1903

***Limnodriloides appendiculatus*** Pierantoni, 1903 (fig. 3)

*Limnodriloides appendiculatus* Pierantoni, 1903: Boll. Soc. Nat. Napoli *17:* 187–188, fig. 1.
not *Limnodriloides appendiculatus:* Boldt 1928: Zool. Anz. *75:* 149–151, figs. 2–3.
not *Limnodriloides appendiculatus:* Hrabě 1967: Spisy přir. Fak. Univ. Brno *485:* 344–345.
*Clitellio appendiculatus* (part): Brinkhurst 1963: Int. Rev. Hydrobiol., Syst. Beih. *2:* 73.
*Limnodriloides fragosus* Finogenova, 1972 (part): Hrabě 1975: Věst. Čs. spol. zool. *39:* 116–118, figs. 9–10; but not Finogenova 1972: Trudy zool. Inst., Leningrad *52:* 98–101, figs. 6–15 [= *L. pierantonii* (Hrabě, 1971); cf. Erséus 1982].
*Limnodriloides appendiculatus:* Erséus 1982: Verh. naturwiss. Ver. Hamburg (NF) *25:* 212–215, fig 1.

Material: Author's collection: 1 whm spm, Saudi Arabia: NE Manifa Bay, about 1000 m inside bay from mouth, subtidal, about 2 m, 23.VIII. 1984; 1 whm spm, Saudi Arabia: near proposed site of Ras Tanajib marine facility, S of small coral reef offshore of well, seagrass bed, subtidal, 2.5 m, 11.VI. 1984; 1 whm spm, Saudi Arabia: off the town Manifa, seagrass bed near coral reef, subtidal, 3 m, 27.V. 1984.

Description of new material: Length (2 complete spms) 3.1.–5.1. mm, from about 33 to about 43 segments (both spms with posterior segments not fully differentiated). Diameter 0.18–0.24 mm. Clitellum extending over 3/4X–XII. Setae (fig. 3a) bifid, with upper tooth thinner than lower, 35–45 µm long, about 2 µm thick, (2) 3 per bundle anteriorly, 2 per bundle in postclitellar segments. Ventral setae absent from XI. Male pores paired in line with ventral setae, posteriorly in XI. Spermathecal pores paired in lateral lines, in middle of X.

Oesophageal diverticula small and slender, in anterior part of IX. Male genitalia (fig. 3b) paired. Vas deferens 12–19 µm wide, slightly longer than atrium, joining atrium slightly sub-apically; lumen of vas narrow. Atrial ampulla 60–75 µm long, maximally (at prostatic pad) 25–28 µm wide, with very thin outer lining. Prostatic pad oval (only moderately developed if compared with Mediterranean material; cf. Remarks) in ventral wall of posterior part of atrial ampulla, broadly attached to lobed prostate

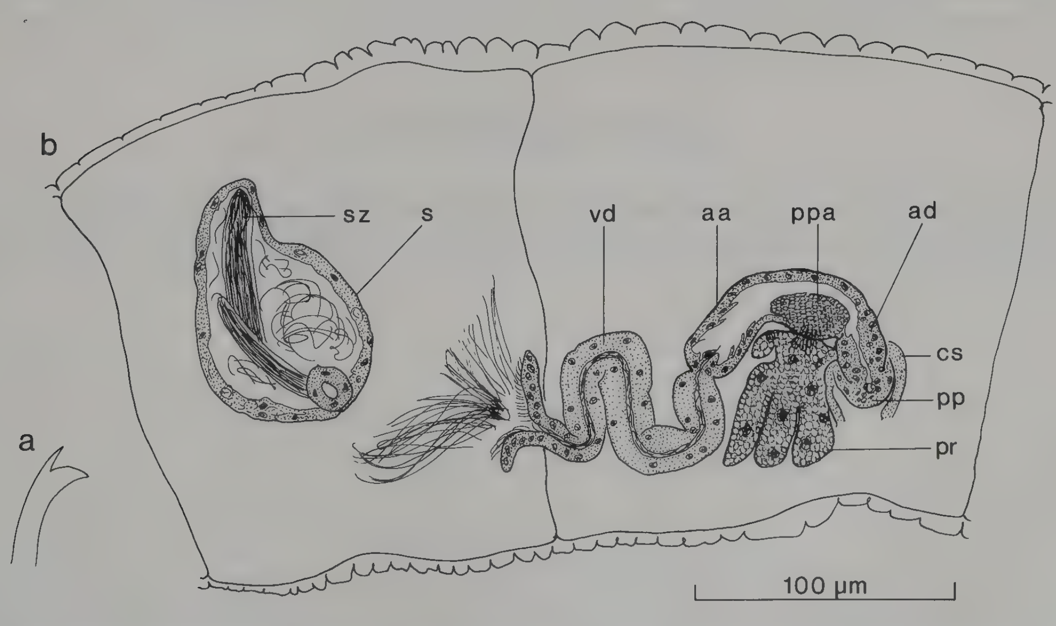


Fig. 3: *Limnodriloides appendiculatus:* a, Free-hand drawing of seta. b, Lateral view of spermatheca and male duct in segments X–XI.

gland. Atrial duct much shorter than ampulla, 17–21 µm wide, terminating in lateral wall of small copulatory (pseudopenial) sac; duct appears not to be granulated. Spermathecae (fig. 3b, s) with very inconspicuous ducts, and round or pear-shaped ampullae, latter only fully developed in one spm, about 100 µm long, 65 µm wide, and containing elongate spermatozeugmata and random sperm in postcopulatory spms.

Remarks: *Limnodriloides appendiculatus* was one of the first marine tubificids to be described (Pierantoni 1903), and it is the type species of the large genus *Limnodriloides.* The species was originally known only from the Bay of Naples in Italy, but as Pierantoni's description was incomplete and the type material lost, the species' identity was long obscure. To solve this problem, a neotype was designated using material from the Naples area by Erséus (1982), who also gave a redescription of the species and provided new records from other parts of the Mediterranean Sea: Corsica (France), Italy and Yugoslavia.

The individuals from the Arabian Gulf are shorter than the Mediterranean worms (which were 6.9–14.1 mm long, consisting of 47–73 segments), and their male ducts (accordingly?) somewhat smaller, but the only noteworthy difference between the two lots of material is that in the Saudi Arabian specimens the prostatic pads are not as well developed as in those from the Mediterranean. In the latter the pads cause the ventral wall of the atria to bulge considerably (cf. Erséus 1982: fig. 1). However, this difference is considered as intra-specific.

Distribution and habitat: Mediterranean Sea (Corsica, Italy, Yugoslavia) and Arabian Gulf Coast of Saudi Arabia (new record). Subtidal, known from 0.5 to 30 m depth, often in seagrass beds.

## DISCUSSION

With the addition of the three species described here to those reported earlier (Erséus 1985), the known marine Tubificidae of the Arabian Gulf number a total of seventeen. Four of these species (*Bathydrilus adriaticus, Phallodrilus rectisetosus, Thalassodrilides gurwitschi* and *Limnodriloides appendiculatus*) are known also from the Mediterranean Sea, and they probably represent a part of the fauna that is capable of wide propagation. *Olavius manifae* and *O. verpa* are more likely to be truly Indo-Pacific species.

## ACKNOWLEDGEMENTS

I wish to thank Ms. R. Deedee Kathman (E.V.S. Consultants Ltd.) and Dr. J.C. McCain (University of Petroleum & Minerals, Dhahran), for placing the material at my disposal; and Ms. Barbro Löfnertz for technical assistance.

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# Oribatid Mites (Acari) of Saudi Arabia

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Abstract: The present paper contains a check-list of 48 species of soil oribatid mites represented in a rather extensive collection from various habitats in the Kingdom of Saudi Arabia. A detailed list of the sampling places is given together with an auxiliary map. Comprehensive identification keys and figures are given to facilitate the separation of the main oribatid groups, families, genera and species.

Keywords: Acari, Oribatida, Archoribatida, Euoribatida, soil mites, identification keys, Saudi Arabia.

قائمة تصنيفية للحلم الخنفسي (الاكاروسات)
في المملكة العربية السعودية

بيومي محمد بيومي و محمد صالح الخليفة

يشمل البحث قائمة تصنيفية مكونة من ٤٨ نوعا من حلم التربة الخنفسي التي تم التعرف عليها في عينات جمعت من بيئات مختلفة بالمملكة العربية السعودية . هذا وقد ادرج بالبحث مفاتيح تصنيفية ورسومات توضيحية لجميع الانواع بالمملكة وذلك لتسهيل التعرف على انواع هذه المجموعة من الاكاروسات .

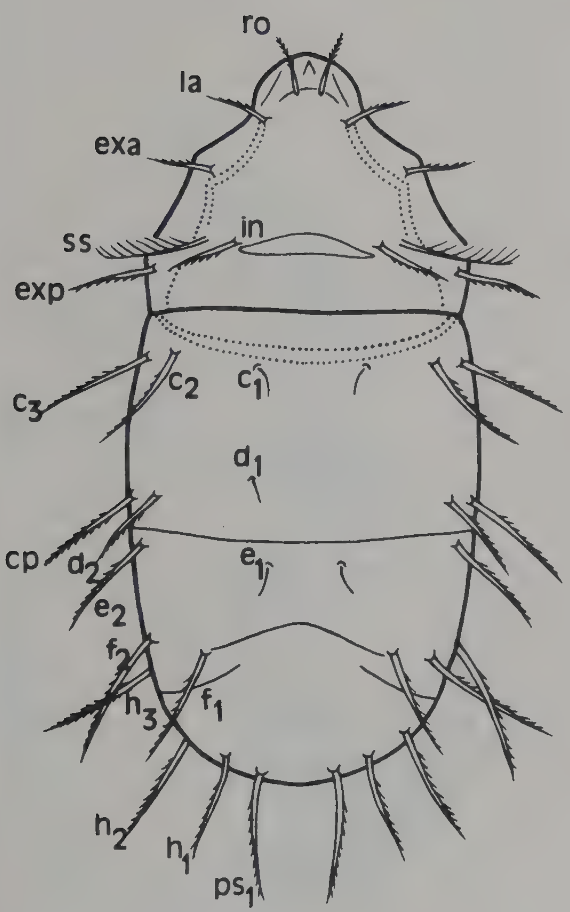
## INTRODUCTION

Oribatid mites constitute one of the richest soil arthropodan groups, both as to the number of individuals and species. An increasing amount of work has been done on this important group in recent years. The cause of this mounting interest is the realization that oribatid mites have a considerably higher economic importance than was hitherto surmised. It was found that several species act as intermediate hosts for various kinds of anoplocephalid cestodes that parasitize economically important farm animals. Furthermore, oribatids have an important role in the biogene phase of the humification of plant debris, and can react very sensitively to changes in natural and agricultural soils, hence they are used as bioindicators for the soils which they inhabit.

Our knowledge of the oribatid mite fauna in the Kingdom of Saudi Arabia is incomplete. Faunal lists containing new records and descriptions of several new species have been published by Al-Khalifa and Bayoumi (1983a, b) and Bayoumi and Al-Khalifa (1983; 1984a, b; 1985). The present study is based primarily on extensive collections made recently by the authors from various biotopes in the Kingdom of Saudi Arabia. The main purpose of this work is to give an up-to-date picture of the oribatid mite fauna in Saudi Arabia, and it serves to lay the foundation for further more extensive taxonomical investigations.

## TERMINOLOGY

Since the identification of oribatid species is based on morphological characters, a brief account about the most important morphological features is essential. The following description is found to be the most simplified one for the nomenclature of the different structures of an oribatid mite (c.f. BALOGH & MAHUNKA, 1980).

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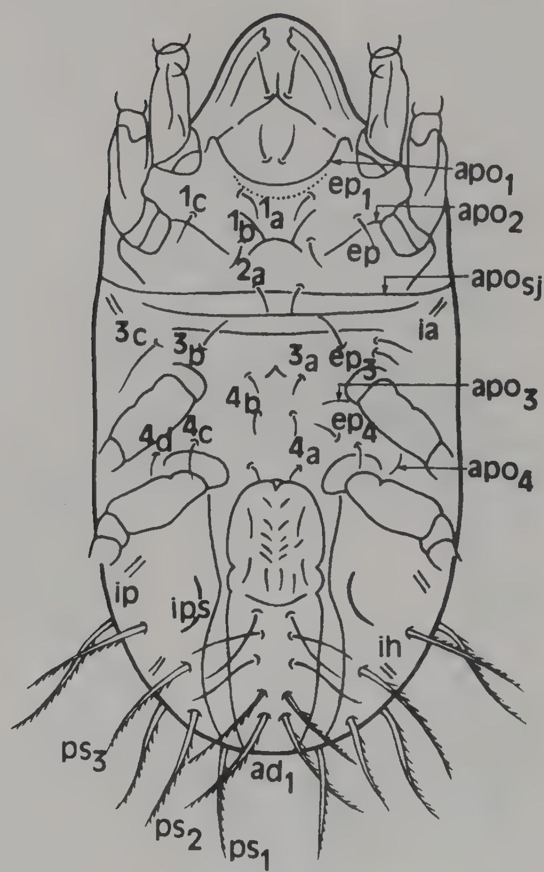


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Fig. 1: Dorsal view of archoribatid mite (with 16 pairs of notogastral setae): ss = sensilli (pseudostigmatic organs); in = interlamellar hairs; la = lamellar hairs; ro = rostral hairs; exp = posterior exostigmatal hairs; exa = anterior exostigmatal hairs; $c_1$, $c_2$, $c_3$ = notogastral hairs of row 1; $d_1$, $d_2$, $d_3$ = notogastral hairs of row 2; $e_1$, $e_2$ = notogastral hairs of row 3; $f_1$, $f_2$ = notogastral hairs of row 4; $h_1$, $h_2$, $h_3$ = notogastral hairs of row 5; $ps_1$, $ps_2$, $ps_3$ = notogastral hairs of last row, ($ps_2$ and $ps_3$ in ventral position!); im = Pori.

Fig. 2: Ventral view of archoribatid mite (with 16 pairs of notogastral setae): $ep_1$, $ep_2$, $ep_3$, $ep_4$ = the four epimeral plates; $apo_1$, $apo_2$, $apo_{sj}$, $apo_3$, $apo_4$ = the five apodemata ($apo_s$) = apodemata sejugales; $1_a$, $1_b$, $1_c$ = hairs of epimere 1 (indicated $1_c$ only !); $2_a$ = hair of epimere 2; $3_a$, $3_b$, $3_c$ = hairs of epimere 3; $4_a$, $4_b$, $4_c$, $4_d$ = hairs of epimere 4; $ad_1$, $ad_2$, $ad_3$, $ad_4$, $ad_5$ = adanal hairs 1 to 5 (indicated $ad_1$ and $ad_2$ only !); $ps_1$, $ps_2$, $ps_3$ = notogastral hairs of last row; ia, ip, ips, ih = pori.

**Dorsal aspect** (figs 1, 3, 5)

The body of an oribatid mite consists, when seen from the dorsal side, of two parts: the prodorsum and the notogaster.

The prodorsum: This region bears 4–6 pairs of hairs: sensilli (ss), interlamellar hairs (in), lamellar hairs (la), rostral hairs (ro), posterior exostigmatic hairs (exp) and anterior exostigmatic hairs (exa). The higher oribatids (suborder Euoribatida) have only one pair of exostigmatic hairs (exp). The sensilli are located in a cup-like growth, the bothridium. The anterior tip of the prodorsum is the rostrum. From the base of the bothridium, there usually extends an outgrowth toward the rostrum. If these

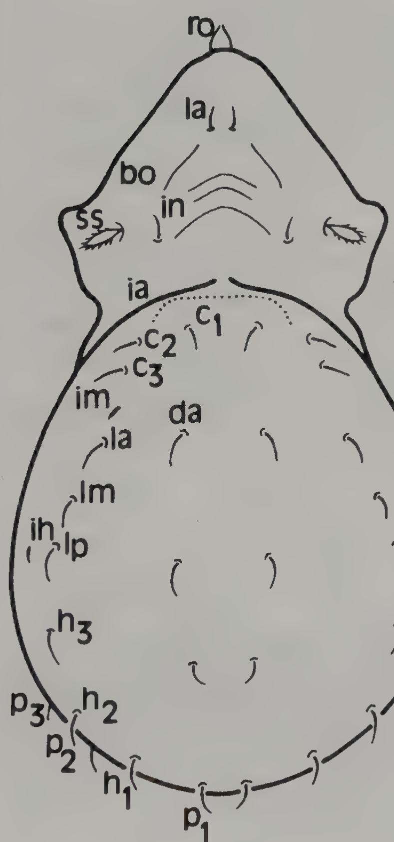


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Fig. 3: Dorsal view of euoribatid mite (with 15 pairs of notogastral setae): ss = sensilli (pseudostigmatal organs); in = interlamellar hairs; la = lamellar hairs; ro = rostral hairs; bo = bothridium (pseudostigma); $c_1$, $c_2$, $c_3$ = hairs of row 1; da, la = hairs of anterior row; dm, lm = hairs of median row; dp, lp = hairs of posterior row; $h_1$, $h_2$, $h_3$ = hairs of row 5; $p_1$, $p_2$, $p_3$ = hairs of last row (older notation of last row = $ps_1$, $ps_2$, $ps_3$); ia, im, ih = pori.

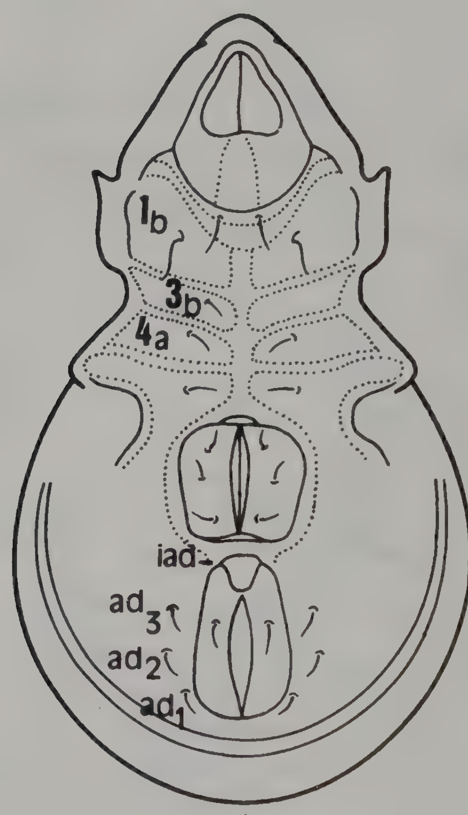


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Fig. 4: Ventral view of euoribatid mite (with 15 pairs of notogastral setae): $1_b$ = hair of epimere 1; $3_b$ = hair of epimere 3; $4_a$ = hair of epimere 4; $ad_1$, $ad_2$, $ad_3$ = adanal hairs 1 to 3; iad = porus.

growths are flat and plate-like, they are called lamellae. If they are, however, rib-like, they are called costulae. Sometimes, the lamellae are connected by a translamella. The prodorsum is separated from the notogaster by a dorsosejugal suture, which is sometimes interrupted or absent.

The notogaster: This region is either undivided, or separated into 2–4 parts by 1–3 transverse sutures (as in some primitive oribatids, suborder Archoribatida). In primitive oribatids, there are usually 16 pairs of notogastral hairs, with often 10 or 14 pairs in higher oribatids. The notogastral hairs are arranged in horizontal rows, each row is designated by certain letters as follows:

a) in primitive oribatids (with 16 pairs of hairs) (fig. 1): $c_1$, $c_2$, $c_3$ + $d_1$, $d_2$, cp + $e_1$, $e_2$ + $f_1$, $f_2$ + $h_1$, $h_2$, $h_3$ + $ps_1$, $ps_2$, $ps_3$;

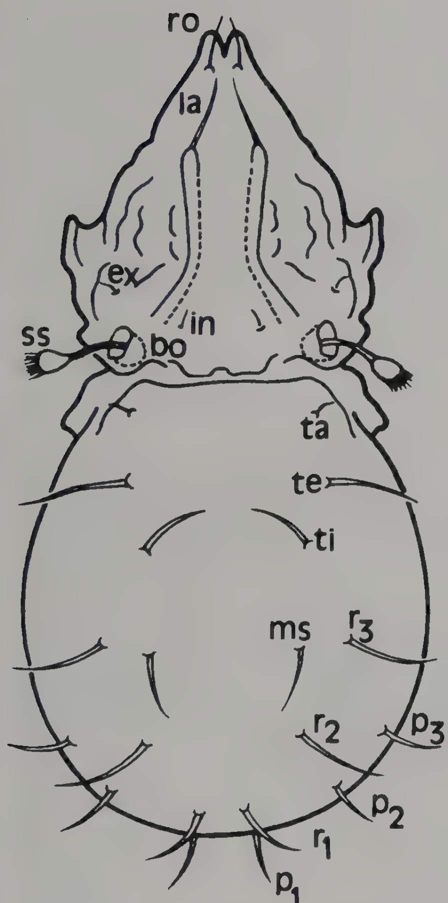


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Fig 5: Dorsal view of euoribatid mite (with 10 pairs of notogastral setae): ss = sensillus (pseudostigmatal organ); in = interlamellar hairs; ex = exostigmatal hairs; la = lamellar hairs; ro = rostral hairs; bo = bothridium (pseudostigmatic organ); the right half of notogaster; ta, te, ti = setal group t; ms = setal group ms; $r_1$, $r_2$, $r_3$ = setal group r; $p_1$, $p_2$, $p_3$ = setal group p.

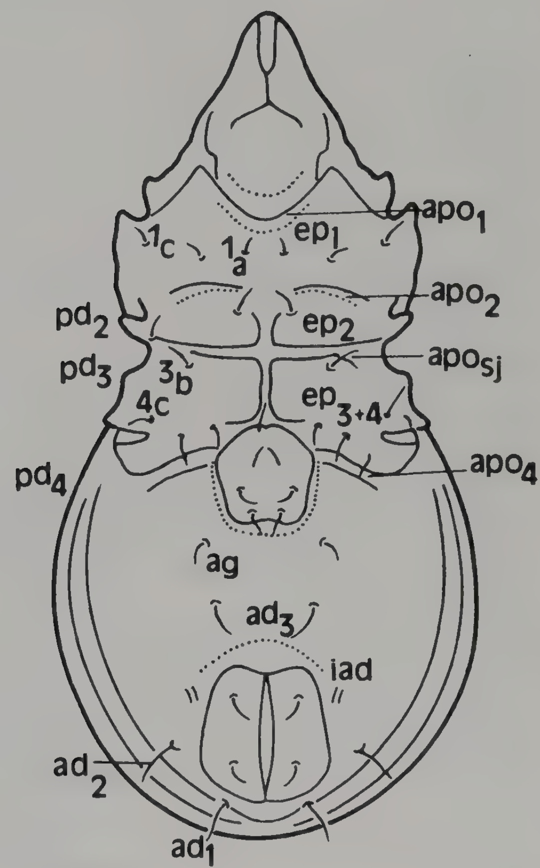


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Fig. 6: Ventral view of euoribatid mite (with 10 pairs of notogastral setae): $1_a$ to $4_c$ = epimeral hairs ; $apo_1$, $apo_2$, $apo_3$, $apo_4$ = the four apodemata ($apo_3$ absent !); $pd_2$, $pd_3$, $pd_4$ = pedotecta 2 to 4; di = discidium; ag = aggenital hairs; $ad_1$, $ad_2$, $ad_3$ = adanal hairs; iad = pori.

b) in higher oribatids (with 14 or 15 pairs of hairs) (fig. 3): $c_1$, $c_2$, $c_3$ + da, la + dm, lm + dp, lp + $h_1$, $h_2$, $h_3$ + $ps_1$, $ps_2$, $ps_3$; and

c) in higher oribatids (with 10 pairs of hairs) (fig. 5): ta, te, ti + ms + $r_1$, $r_2$, $r_3$ + $p_1$, $p_2$, $p_3$.

In some members of the higher oribatids, the external anterior border of the notogaster bears a wing-like appendage called "pteromorpha". The notogaster of many oribatids has special respiratory organs, viz. areae porosae, sacculi and pori. The areae porosae are circular organs, supplied with fine pores. These areae porosae are usually eight in number and are designated as follows: aa, $a_1$, $a_2$, $a_3$. The sacculi are small sacs sunk below the cuticle, with only a slit-like opening on the surface. They are designated as: sa; $s_1$, $s_2$, $s_3$. In some cases, only pores are present on the notogastral surface (pa, $p_1$, $p_2$, $p_3$). There are frequently also five pairs of slit-like pores on the notogaster (ia, im, ip, ih, ips).

### **Ventral aspect** (figs 2, 4, 6)

The ventral surface of an oribatid mite consists of two regions, the epimeral and the genito-anal regions.

The epimeral region: This region occupies the area between the gnathosoma and genital plates. It is covered by four epimeral plates: $ep_1$, $ep_2$, $ep_3$, $ep_4$. These plates are separated from each other by chitinous thickenings called "apodemata". There are four apodemata: $apo_1$, $apo_2$, $apo_3$, $apo_4$. The setae arising on the epimeres are denoted by a number and a letter. The epimeral setal formula indicates the number of setae arising on the four epimeres, e.g. 3133 means that there are 3 setae on epimere 1, 1 on epimere 2, 3 on epimere 3, and 3 on epimere 4. In addition, four pairs of legs arise lateral to the epimeral region.

The genito-anal region: It is the area found behind the epimeral region of the ventral side. Two types may be recognised:

a) macropyline type: the genital and anal plates touch each other and occupy most of the genito-anal region. Long aggenital and adanal plates are frequently present lateral to the genital and anal plates, respectively. The genital plates often carry ten pairs of genital setae. The anal plates bear two pairs of setae, and the adanal plates have four pairs of setae. This type is characteristic of the primitive oribatids;

b) brachypyline type: the genital and anal plates are separated from each other. The genital plates often carry six or four pairs of setae. One pair of aggenital setae, two pairs of anal setae, and three pairs of adanal setae are present. Usually, there is a pair of slit-like pores (iad) found lateral to the anal plates. This type is characteristic of the higher ribatids.

## SAMPLING AND EXTRACTION

Soil and litter samples were taken from 49 localities distributed through a variety of biotopes in the Kingdom of Saudi Arabia, as indicated in the appended map (fig. 7). The types of soils, kinds of vegetations and dates of sampling in the localities investigated are presented in the submitted list.

A metal quadrangular frame (10 × 10 × 8 cm) was used for sampling. Animals were extracted in paper funnels, as recommended by Balogh (1958). Small tubes containig 70% ethyl alcohol with a few drops of ethylene glycol served as traps. Trapped mites were separated from other soil animals under a stereoscopic binocular microscope. The mites were cleared in lactic acid and the temporary preparation method, described by Grandjean (1949), has been adopted for microscopic identification.

**Table: The sampling localities.**

| Number and name of locality | Type of soil and vegetation | Date of sampling |
|---|---|---|
| 1. Riyādh | loamy soil under *Tamarix* trees. | 13.IX.1981 |
| 2. Al-Kharj | loamy soil under palm trees. | 25.VI.1981 |
| 3. Ḍurmā | silty-loamy soil under *Ziziphus* sp. | 29.VI.1981 |
| 4. Al-Dawadmī | litter of Al-Ghada trees. | 4.VII.1981 |
| 5. Al-Dir'iyah | litter of *Ficus nitida.* | 29.VI.1981 |
| 6. Ṣalbūkh | silty-loamy soil under *Tamarix* trees. | 13.VII.1981 |
| 7. Shaqrā' | litter of *Citrus* trees. | 16.II.1982 |
| 8. Thadiq | sandy soil under grapes. | 12.III.1982 |
| 9. 'Awdat Sudayr | litter of *Ficus nitida.* | 16.X.1982 |
| 10. Ḥawṭat Sudayr | loamy soil under mint plantation. | 16.X.1982 |
| 11. Jalājil | litter of palm trees. | 16.X.1982 |
| 12. Al-Majma'ah | silty-loamy soil under palm trees. | 17.X.1982 |
| 13. Al-Ghāṭ | loamy soil planted with *Alfalfa.* | 17.X.1982 |
| 14. Al-Zulfī | sandy soil under *Acacia* trees. | 17.X.1982 |
| 15. Al-Mithnab | sandy-loamy soil under mint plantation. | 25.XII.1981 |
| 16. Al-Badāya | litter of palm trees. | 12.III.1982 |
| 17. Al-Rass | silty-loamy soil under palm trees. | 25.XII.1982 |
| 18. Al-Shinānah | loamy soil under *Tamarix* trees. | 25.XII.1982 |
| 19. 'Unayzah | loamy soil under grapes. | 3.I.1982 |
| 20. Al-Khabrā' | sandy soil under palm trees. | 13.IV.1982 |
| 21. Al-Bukayriyah | silty-loamy soil under pomegranate. | 13.IV.1982 |
| 22. Buraydah | litter of *Tamarix* trees. | 13.IV.1982 |
| 23. Hufūf | sandy soil under *Tamarix* trees. | 12.III.1983 |
| 24. Dammām | litter of palm trees. | 12.III.1983 |
| 25. Al-Qaṭīf | loamy soil under *Ficus* trees. | 12.III.1983 |
| 26. Ḥafr-Al-Bāṭin | sandy soil under *Acacia* trees. | 15.VI.1982 |
| 27. Al-Qaysūmah | sandy-loamy soil from pasture land. | 15.VI.1982 |
| 28. Ṭurayf | loamy soil under *Heuna* trees. | 15.VI.1982 |
| 29. Al-Madīnah | litter of *Tamarix* trees. | 21.III.1983 |
| 30. Qubā | litter of *Ficus* trees. | 21.III.1983 |
| 31. Al-'Uwaynah | sandy soil under palm trees. | 21.III.1983 |
| 32. Al-Khalil | loamy soil under grapes. | 21.III.1983 |
| 33. Baḥrah | silty-loamy soil planted with *Alfalfa.* | 16.II.1982 |
| 34. Al-Jamūm | litter of palm trees. | 16.II.1982 |
| 35. Al-Sharā'yi | loamy soil under pomegranate trees. | 16.II.1982 |
| 36. Al-Sayl Al-Kabir | loamy soil from pasture land. | 17.II.1982 |
| 37. Abhā | loamy soil under *Tamarix* trees. | 25.X.1982 |
| 38. Khamīs Mushayṭ | sandy-loamy soil under *Ziziphus* trees. | 26.X.1982 |
| 39. Al-Sūdah | loamy soil of a moss cushion. | 25.X.1982 |
| 40. Al-Surrah | loamy soil of a moss cushion. | 25.X.1982 |
| 41. Al-Qar'ah | silty-loamy soil under mint plants. | 25.X.1982 |
| 42. Ṣabiā | litter of *Citrus* trees. | 26.X.1982 |
| 43. Abū-'arish | litter of palm trees. | 27.X.1982 |
| 44. Ṣāmiṭah | sandy soil under *Ficus* trees. | 27.X.1982 |
| 45. Khamasin | litter of *Acacia* trees. | 6.I.1983 |
| 46. Al-Sulayil | loamy soil under mint plants. | 6.I.1983 |
| 47. Qaṣr Hamām | litter of *Tamarix* trees. | 6.I.1983 |
| 48. El-Bidya | sandy soil under grapes. | 6.I.1983 |
| 49. Lalā | loamy soil under *Citrus* trees. | 6.I.1983 |


Fig. 7: Map of Saudi Arabia showing the sampling localities.

## CHECK-LIST OF THE IDENTIFIED SPECIES

The following check-list is arranged according to the system of Balogh & Mahunka (1980). Specific references to localities in the check-list contain both the number of the locality as shown on the map (fig. 7) and the number of collected individuals are given in parenthesis. In addition, the name of species is followed by the number of the figure.

## A: Suborder Archoribatida Balogh & Mahunka, 1980

Fam. Phthiracaridae Perty, 1841

*Hoplophorella scapellata* Aoki, 1965 (fig. 8)
Localities: 8(2), 29(1).

Fam. Euphthiracaridae Jacot, 1930

*Rhysotritia ardua* (C.L. Koch, 1841) (fig. 9)
Localities: 1(3), 7(2), 11(8), 21(15), 35(3), 49(21).

Fam. Lohmanniidae Berlese, 1916

*Heptacarus ornatus* Bayoumi et Al-Khalifa, 1984 (fig. 10)
Locality: 2(9).

*Cryptacarus promecus* (Grandj, 1950) (fig. 11)
Localities: 39(2), 42(1).

*Lohmannia regalis* (Berl., 1923) (fig. 12)
Localities: 19(5), 21(3), 22(1).

Fam. Epilohmanniidae Oudemans, 1923

*Epilohmannia cylindrica* (Berl., 1904) (fig. 13)
Localities: 1(22), 4(13), 9(2), 15(3), 20(5), 24(7).

*Epilohmannia pallida aegyptica* Bayoumi & Mahunka, 1976 (fig. 14)
Localities: 2(32), 5(13), 7(2), 12(5), 14(2), 18(3), 21(15), 28(3), 34(2), 37(2), 47(1).

Fam. Nothridae Berlese, 1896

*Nothrus biciliatus* (C.L. Koch, 1841) (fig. 15)
Localities: 5(2), 39(4).

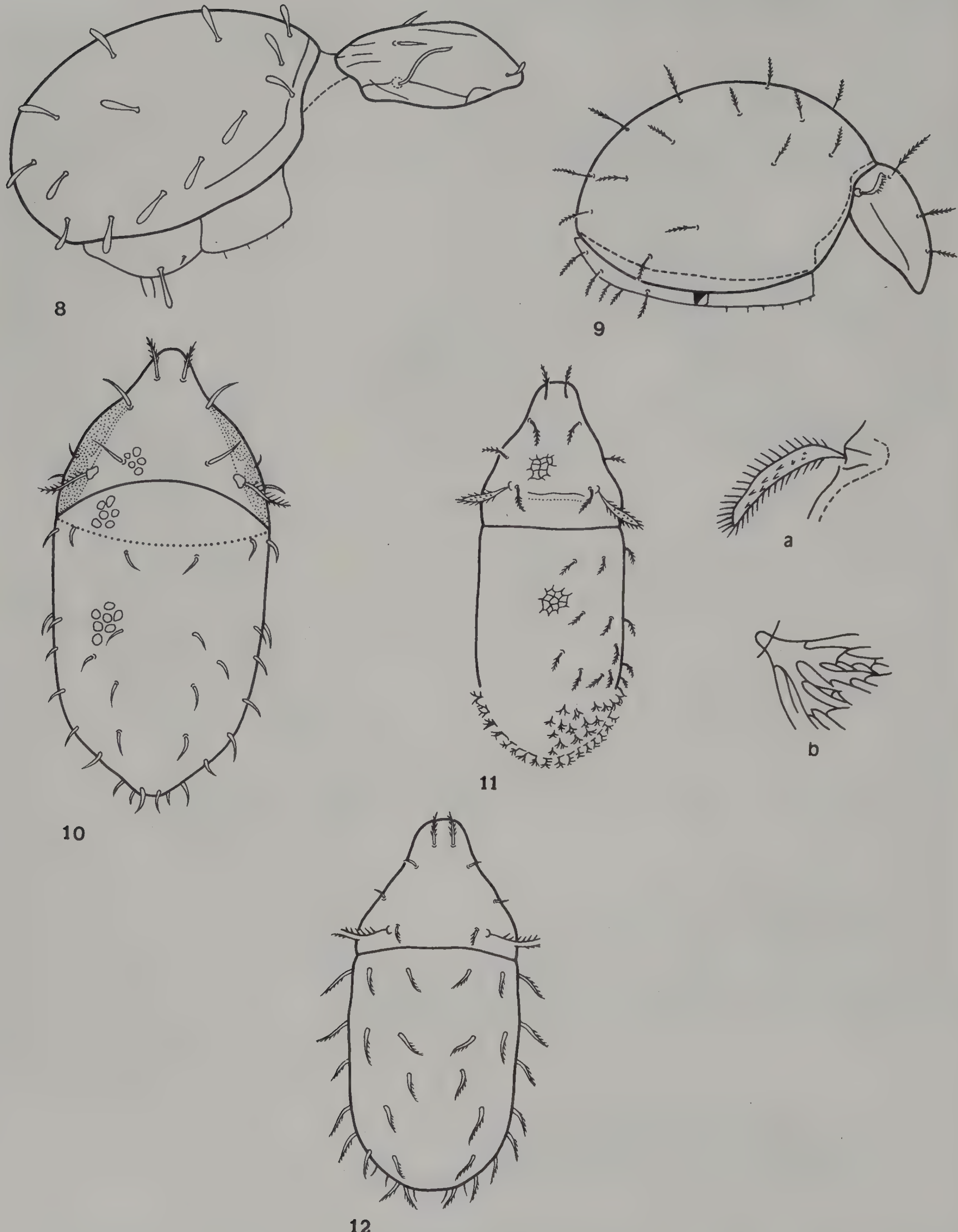
*Nothrus palustris* (C.L. Koch, 1839) (fig. 16)
Localities: 18(3), 36(2), 41(3).

Fam. Malaconothridae Berlese, 1916

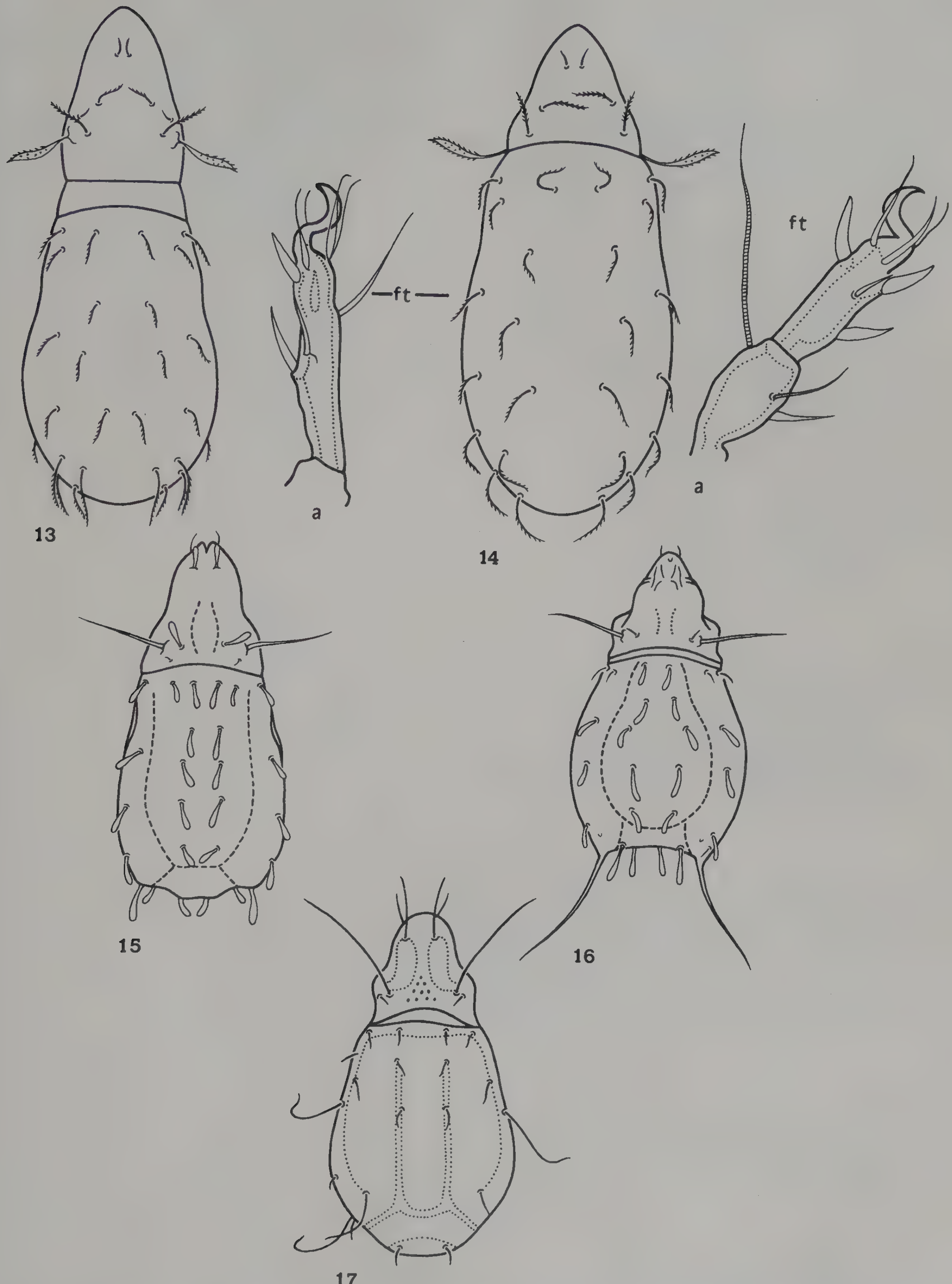
*Trimalaconothrus novus* (Sellnick, 1922) (fig. 17)
Localities: 39(1), 47(1).

Fam. Nanhermanniidae Sellnick, 1928

*Cyrthermannia ezzati* Bayoumi & Mahunka, 1977 (fig. 18)
Locality: 43(2).




Figs 8–12: 8, *Hoplophorella scapellata* ; 9 , *Rhysotritia ardua* ; 10, *Heptacarus ornatus*; 11, *Cryptacarus promecus*, a, Sensillus, b, Notogastral hair; 12, *Lohmannia regalis*.




Figs 13–17: 13, *Epilohmannia cylindrica*, a, Tarsus IV; 14, *Epilohmannia Pallida aegyptica*, a, Tarsus IV; 15, *Nothrus biciliatus*; 16, *Nothrus palustris*; 17, *Trimalaconothrus novus*.

**B: Suborder Euoribatida** Balogh & Mahunka, 1980

Fam. Hermanniellidae Grandjean, 1934

*Hermanniella septentrionalis* Berl., 1910 (fig. 19)

Locality: 39(2).

Fam. Microzetidae Grandjean, 1936

*Berlesezetes auxiliaris* Grandj., 1936 (fig. 20)

Localities: 5(1), 24(3).

*Berlesezetes kingi* Bayoumi & Al-Khalifa, 1984 (fig. 21)

Locality: 18(3).

Fam. Eremulidae Grandjean, 1965

*Eremulus flagellifer* Berl., 1908 (fig. 22)

Localities: 38(1), 42(2).

Fam. Damaeolidae Grandjean, 1965

*Fosseremus laciniatus* (Berl., 1905) (fig. 23)

Localities: 10(2), 17(5).

*Fosseremus quadripertitus* Grandj., 1965 (fig. 24)

Locality: 40(2).

Fam. Tectocepheidae Grandjean, 1954

*Tectocepheus velatus* (Michael, 1884) (fig. 25)

Localities: 3(5), 6(17), 23(4), 45(6), 48(12).

*Tectocepheus sarekensis* (Tragardh, 1910) (fig. 26)

Localities: 1(15), 10(6), 16(2), 25(3), 32(17), 40(6).

Fam. Carabodidae C.L. Koch, 1837

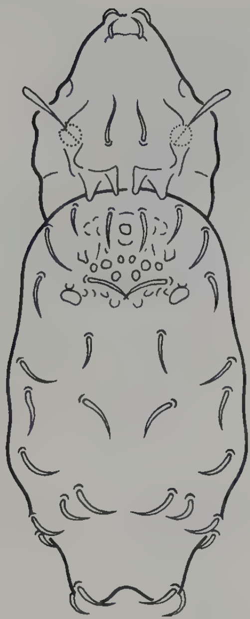
*Carabodes reticulatus* Berlese, 1916 (fig. 27)

Locality: 46(2).

Fam. Oppiidae Grandjean, 1954

*Oppia arcidiaconoae* Bernini, 1973 (fig. 28)

Locality: 44(3).



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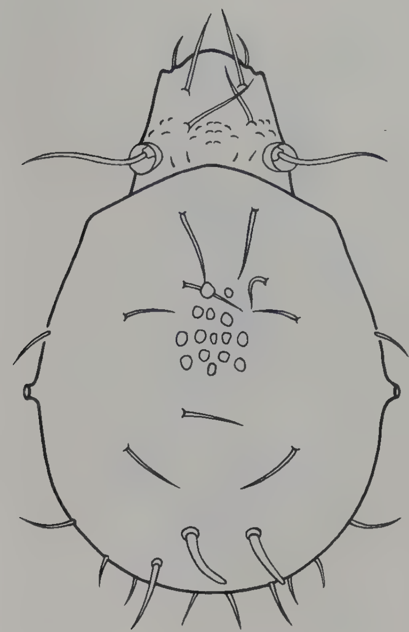

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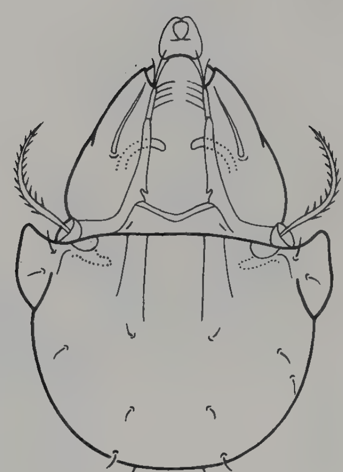

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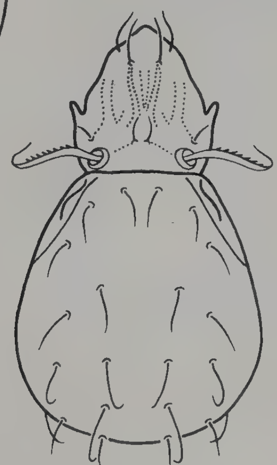

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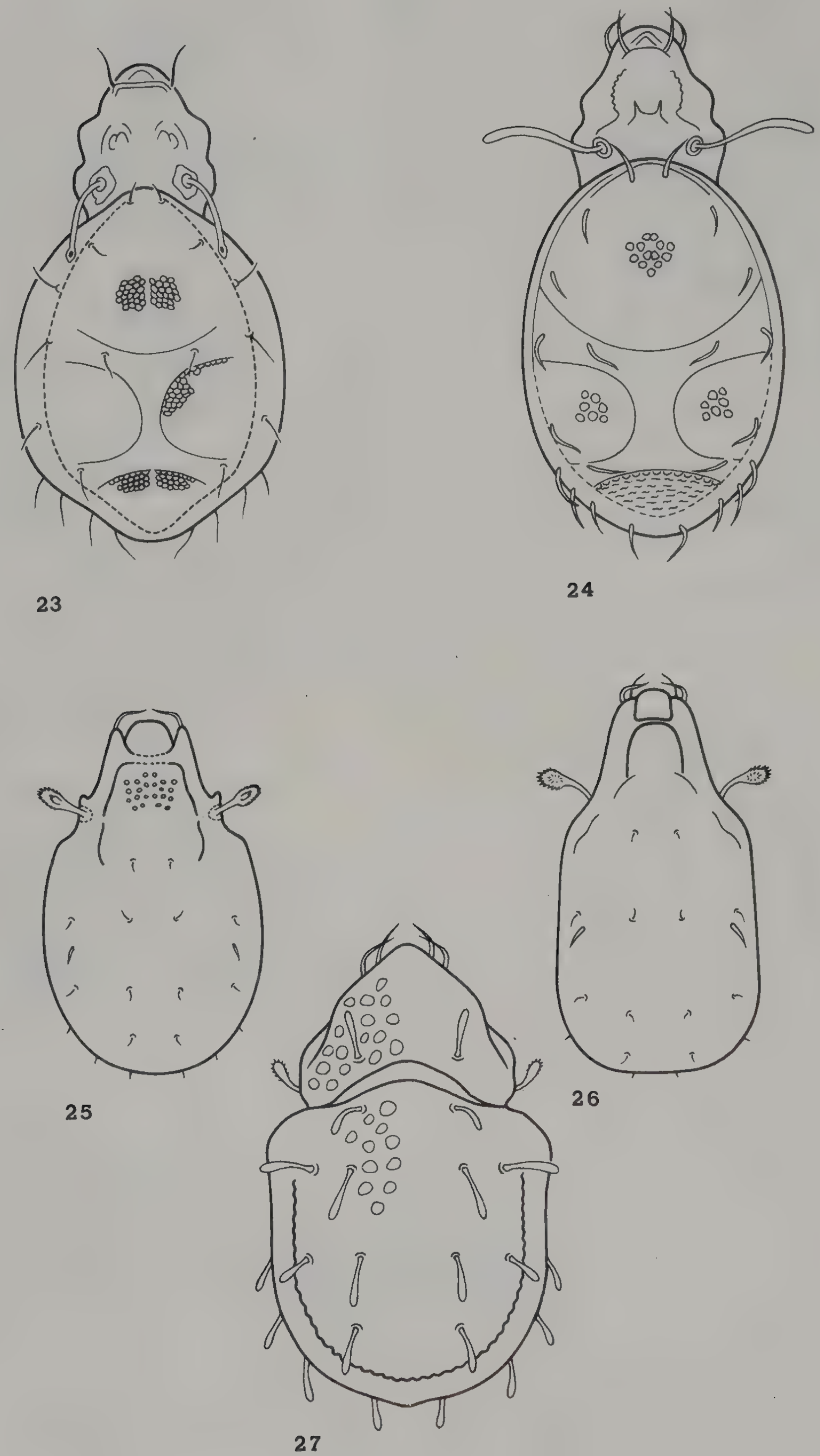
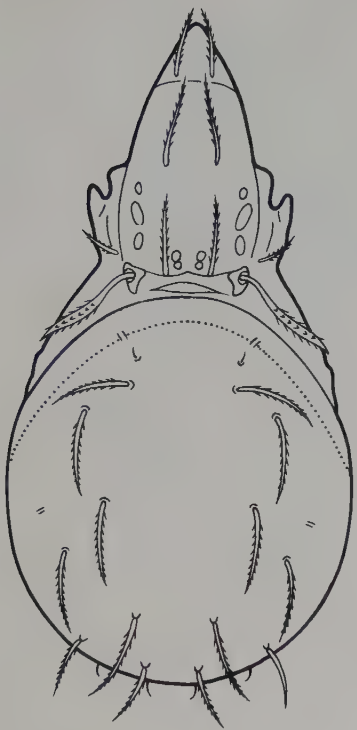
Figs 18–22: 18, *Cyrthermannia ezzati*; 19, *Hermanniella septentrionalis*; 20, *Berlesezetes auxiliaris*; 21, *Berlesezetes kingi*; 22, *Eremulus flagellifer*.




Figs 23–27: 23, *Fosseremus laciniatus*; 24, *Fosseremus quadripertitus*; 25, *Tectocepheus velatus*; 26, *Tectocepheus sarekensis*; 27, *Carabodes reticulatus*.



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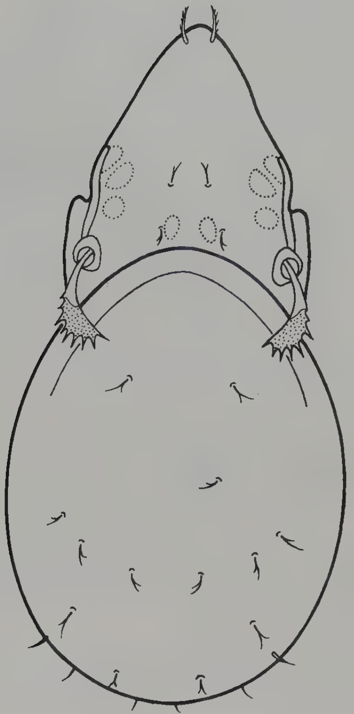

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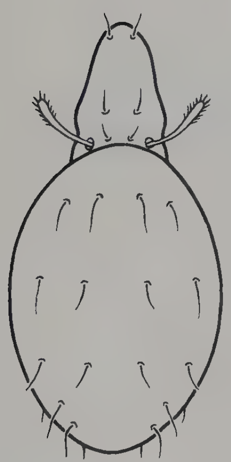

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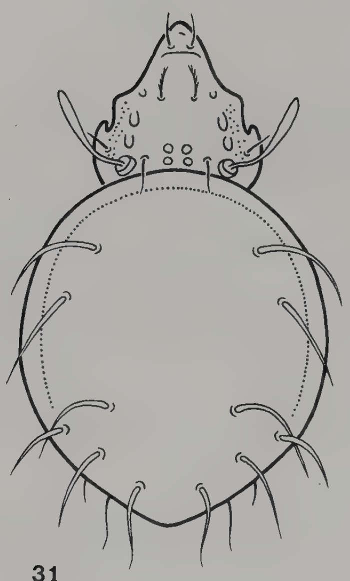

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Figs 28–31: 28, *Oppia arcidiaconoae*; 29, *Oppia bifidus*; 30, *Oppia clavipectinata*; 31, *Oppia concolor*.

*Oppia bifidus* Bayoumi & Al-Khalifa, 1984 (fig. 29)
Localities: 2(20), 5(2), 30(12).

*Oppia clavipectinata* (Michael, 1884) (fig. 30)
Locality: 44(5).

*Oppia concolor* (C.L. Koch) (fig. 31)
Localities: 13(2), 26(2).

*Oppia cylindrica* Perez-Inigo, 1964 (fig. 32)
Localities: 6(1), 12(5), 27(3), 48(2).

*Oppia fasciata* (Paoli, 1908) (fig. 33)
Localities: 31(2), 49(5)

*Oppia foveolata* (Paoli, 1908) (fig. 34)
Localities: 33(6), 44(2), 49(5).

*Oppia varians* Wallwork, 1961 (fig. 35)
Locality: 40(7).

*Oppiella nova* (Oudemans, 1902) (fig. 36)
Localities: 4(13), 9(22), 15(3), 21(6), 32(12), 38(8), 47(6).

*Striatoppia niliaca* (Popp, 1960) (fig. 37)
Locality: 48(2).

Fam. Passalozetidae Grandjean, 1954

*Passalozetes nitidus* Bayoumi & Al-Khalifa, 1984 (fig. 38)
Locality: 37(12).

Fam. Oribatulidae Thor, 1929

*Oribatula tibialis* (Nicolet, 1855) (fig. 39)
Locality: 44(2).

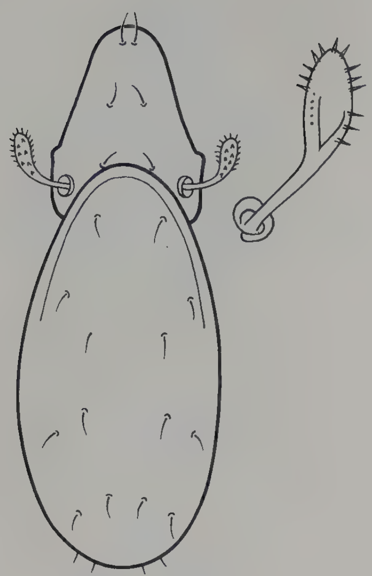
*Scheloribates fimbriatus africanus* Wallwork, 1964 (fig. 40)
Localities: 32(2), 45(3).

*Scheloribates laevigatus* (C.L. Koch, 1836) (fig. 41)
Localities: 1(2), 3(15), 11(26), 14(38), 25(31), 36(12), 44(5).

*Scheloribates pallidulus* (C.L. Koch, 1840) (fig. 42)
Localities: 31(2), 40(5).

*Scheloribates saudicus* Bayoumi & Al-Khalifa, 1984 (fig. 43)
Localities: 2(2), 5(6).

*Zygoribatula cognata* (Oudemans, 1902) (fig. 44)
Localities: 44(3), 49(5).



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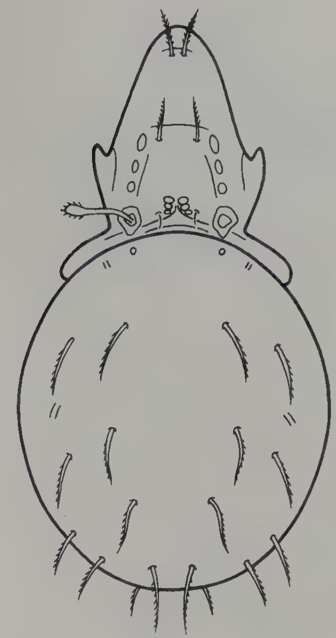

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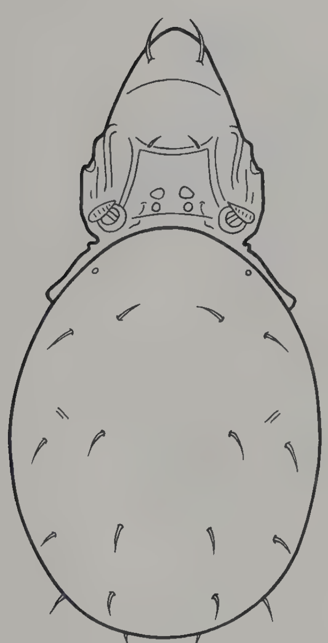

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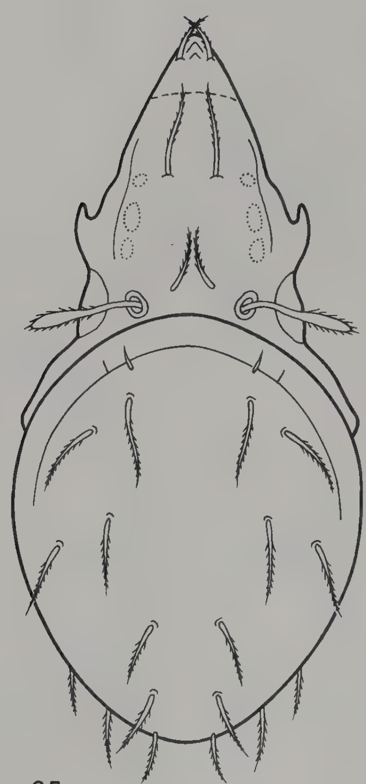

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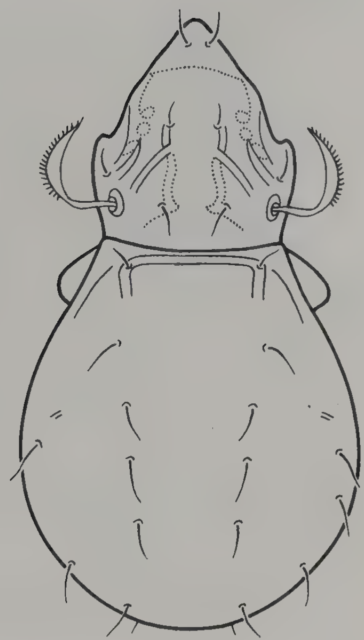
Figs 32–35: 32, *Oppia cylindrica*, a, Sensillus; 33, *Oppia fasciata*; 34, *Oppia foveolata*, a, Sensillus; 35, *Oppia varians*.



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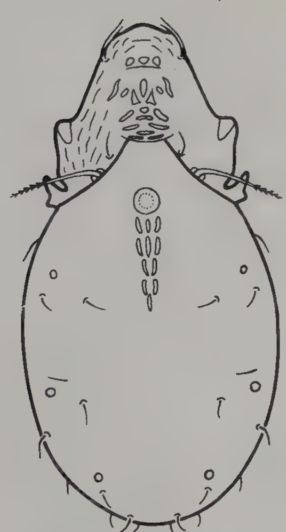

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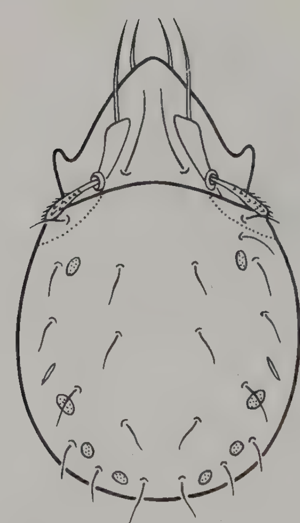

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Figs 36–39: 36, *Oppiella nova*; 37, *Striatoppia niliaca*; 38, *Passalozetes nitidus*; 39, *Oribatula tibialis*.

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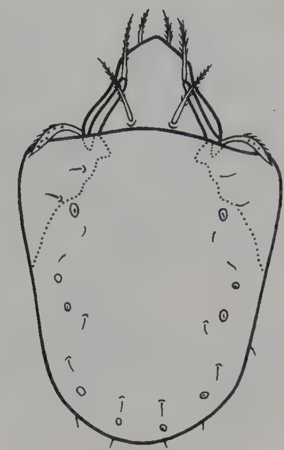

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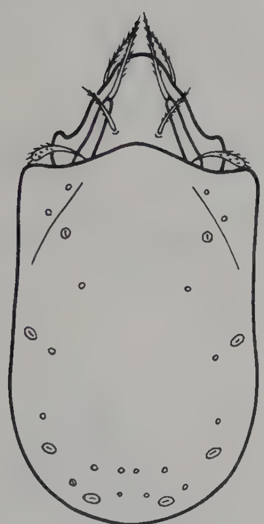

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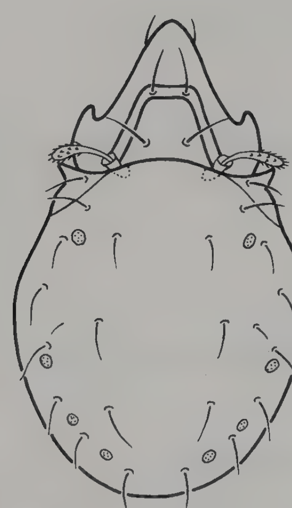

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Figs 40–44: 40, *Scheloribates fimbriatus africanus*; 41, *Scheloribates laevigatus*; 42, *Scheloribates pallidulus*; 43, *Scheloribates saudicus*; 44, *Zygoribatula cognata*.

Fam. Haplozetidae Grandjean, 1936

*Rostrozetes foveolatus* Sellnick, 1925 (fig. 45)
Localities: 42(2), 47(5).

*Xylobates capucinus* (Berlese, 1904) (fig. 46)
Localities: 14(2), 32(6), 48(12).

Fam. Ceratozetidae Grandjean, 1954

*Hypozetes translamellatus saudicus* Bayoumi & Al-Khalifa, 1984 (fig. 47)
Locality: 39(23).

Fam. Mochlozetidae Grandjean, 1960

*Unguizetes reticulatus* Wallwork, 1965 (fig. 48)
Locality: 37(2).

Fam. Pelopidae Ewing, 1917

*Peloptulus phaenotus* (C.L. Koch, 1844) (fig. 49)
Locality: 39(3).

Fam. Oribatellidae Jacot, 1925

*Lamellobates hauseri aegypticus* Bayoumi, 1979 (fig. 50)
Locality: 40(12).

*Paralamellobates ceylanicus* (Oudemans, 1915) (fig. 51)
Locality: 48(5).

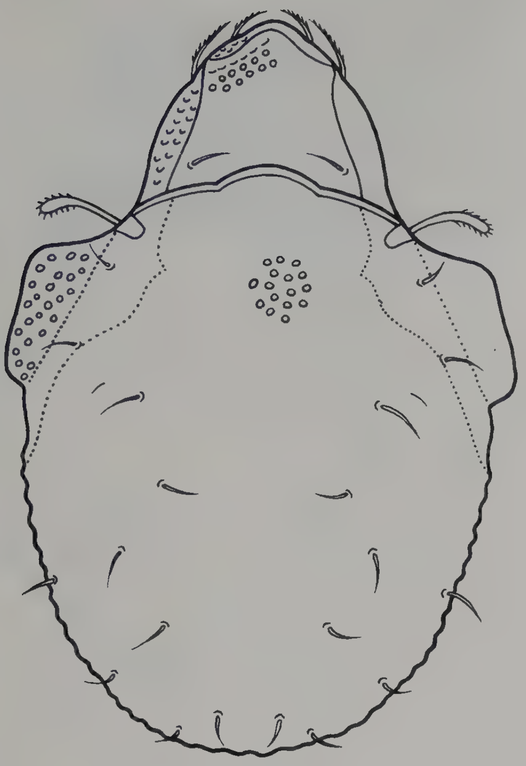
Fam. Galumnidae Jacot, 1925

*Galumna arabica* Bayoumi & Al-Khalifa, 1984 (fig. 52)
Locality: 42(12).

*Galumna flabellifera* Hammer, 1958 (fig. 53)
Localities: 42(3), 47(5).

*Galumna flagellata* (Willmann, 1923) (fig. 54)
Locality: 47(2).

*Pilogalumna arabica* Bayoumi & Al-Khalifa, 1984 (fig. 55)
Locality: 18(3)



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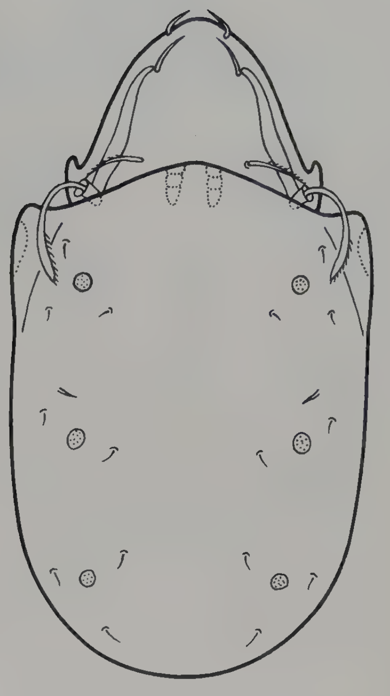
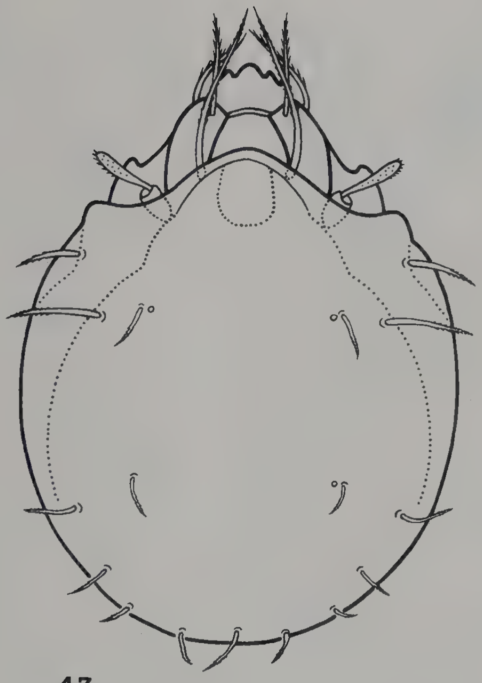
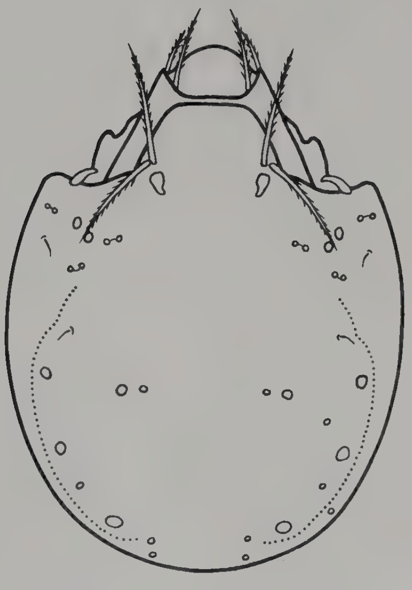


46



47



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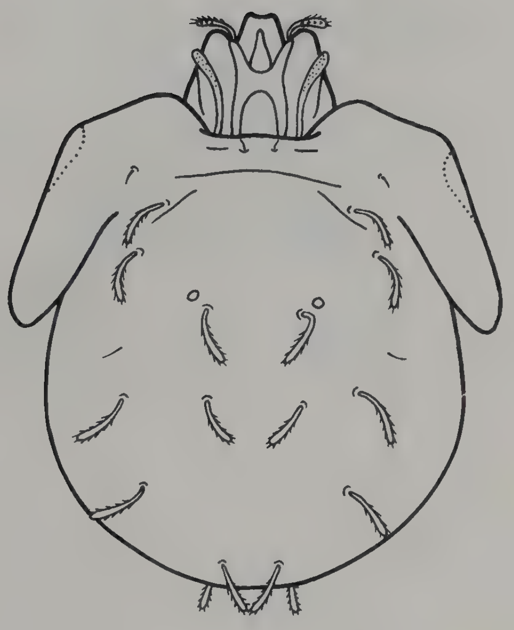
Figs 45–48: 45, *Rostrozetes foveolatus*; 46, *Xylobates capucinus*; 47, *Hypozetes translamellatus saudicus*; 48, *Unguizetes reticulatus*.



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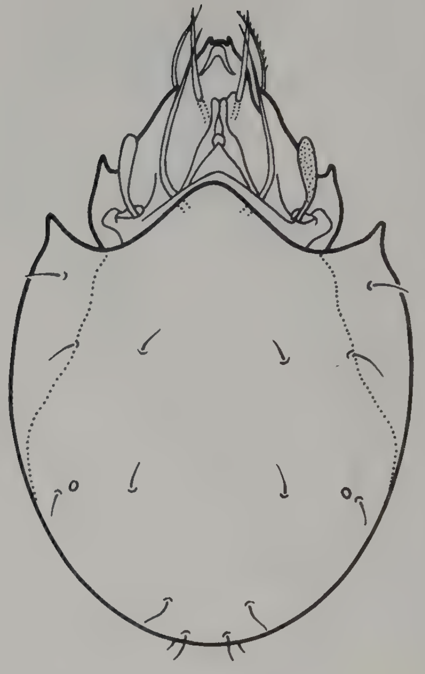

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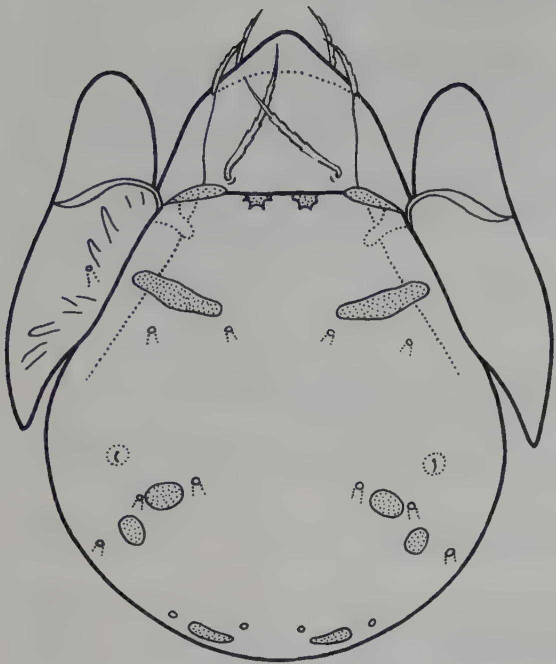
Figs 49–51: 49, *Peloptulus phaenotus*; 50, *Lamellobates hauseri aegypticus*; 51, *Paralamellobates ceylanicus*.



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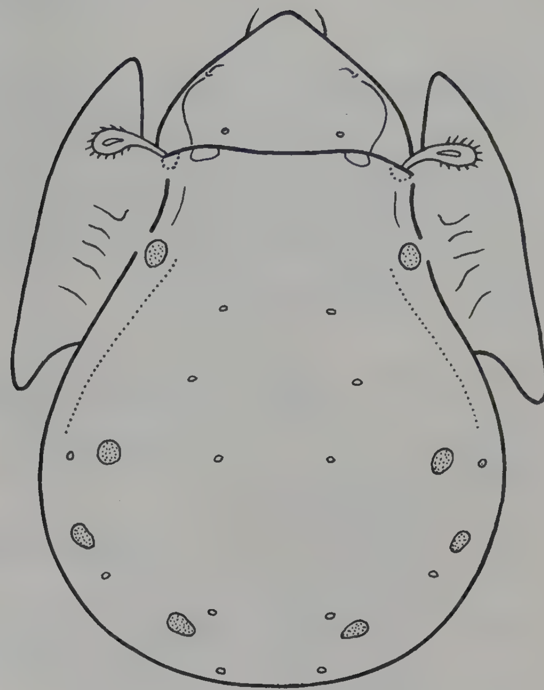

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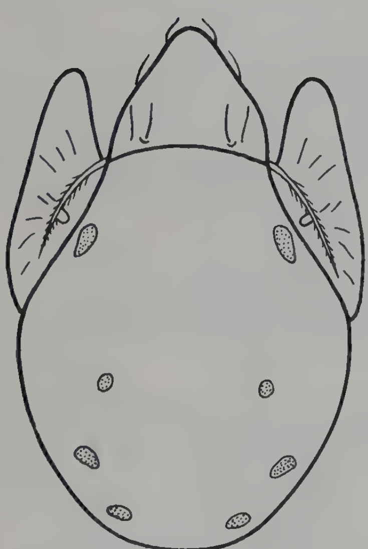

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Figs 52–55: 52, *Galumna arabica*; 53, *Galumna flabellifera*; 54, *Galumna flagellata*; 55, *Pilogalumna arabica*.

## IDENTIFICATION KEYS

1(2). Genital and anal plates very close to each other occupying the whole length of the ventral surface, or the ventral plate is divided into two parts by semicircular or parabolic lines. Separate anal and adanal plates usually present. Suborder **Archoribatida** (I)

2(1). Genital and anal plates separated, not occupying the whole length of the ventral surface, and the ventral plate is not divided by sutures. Adanal plate absent not separate from ventral plate. Suborder **Euoribatida** (II)

### I. Key to families, genera and species of the suborder Archoribatida

1(10). The prodorsum cannot be shut back like the blade of a pen-knife to the notogaster. Body flattened dorso-ventrally.

2(5). Body dichoid, i.e. an unsclerotized region is present on the ventral surface between the 2nd and 3rd pairs of legs.

3(4). A wide or narrow preanal plate present between genital and anal plates. Ten pairs of genital (6+4), 2 pairs of anal and 4 pairs of adanal setae present. Fam. **Lohmanniidae**

a(d) Preanal plate broad.

b(c) Anal and adanal plates fused. Genus ***Heptacarus*** (*H. ornatus*)

c(b) Anal and adanal plates separated. Genus ***Lohmannia*** (*L. regalis*)

d(a) Preanal plate narrow. Genus ***Cryptacarus*** (*C. promecus*)

4(3). Preanal plate absent. A horizontal suture separates the genital and anal plates. Eight pairs of genital setae present. Fam. **Epilohmanniidae** (Genus *Epilohmannia*)

a(b) Seta "ft" on tarsus of leg IV thick, short and thorn-like. ***E. pallida aegyptica***

b(a) Seta "ft" on tarsus of leg IV thin, long, barbed and setiform. ***E. cylindrica cylindrica***

5(2). Body holoid, i.e. the ventral surface between the 2nd and 3rd pairs of legs is immovably fused.

6(9). A separate adanal plate present, on which adanal hairs arise.

7(8). Bothridium and sensillus well-developed. The shape of sensillus differs from the rest of the prodorsal hairs. Epimeral neotrichy present. Fam. **Nothridae** (Genus *Nothrus*)

a(b) Notogastral seta "$k_1$" is very long, with tapering distal end. Seta $c_2$ marginally situated, nearer to seta $c_3$ than to seta $c_1$. ***N. palustris***

b(a) Notogastral seta "$k_1$" short, spatulate. Seta $c_2$ not marginally situated, nearer to seta $c_1$ than to seta $c_3$. ***N. biciliatus***

8(7). Bothridium reduced. Sensillus (if present) is in the form of a simple hair. Epimeral neotrichy absent, 9–10 pairs of epimeral setae present.
Fam. **Malaconothridae** (Genus *Trimalaconothrus, T. novus*)

9(6). Adanal plate fused with ventral plate, adanal setae do not arise on its plate, notogaster with 16 pairs of setae, without lateral tubes.
Fam. **Nanhermanniidae** (Genus *Cyrthermannia, C. ezzati*)

10(1). The above characters are absent, the prodorocum can be shut back like the blade of a pen-knife to the notogaster. Body compressed laterally.

11(12). Ano-genital region wide, valves of plates more or less quadrangular.
Fam. **Phthiracaridae** (Genus *Hoplophorella, H. scapellata*)

12(11). Ano-genital region narrow, valves of plates elongated.
Fam. **Euphthiracaridae** (Genus *Rhysotritia, R. ardua*)

## II. Key to families and genera of the suborder Euoribatida

1(14). Notogaster with downward bending pteromorphae, or at least horizontal pteromorphae; in this latter case areae porosae, sacculi, or pori always present on notogaster.

2(3). Pteromorphae ear-like, extending far anteriorly and posteriorly, lamellae reduced to a line. Fam. **Galumnidae**

a(b) Lamellar and sublamellar lines (L & S lines) present. Lamellar setae originate between L & S lines. Genus ***Galumna*** (see key "A" for species separation)

b(a) Lamellar and sublamellar lines (L & S) absent. Genus ***Pilogalumna*** (*P. arabica*)

3(2). Pteromorphae never ear-like, not extending far anteriorly or posteriorly.

4(5). Chelicerae with bacilliform lateral appendage. Lamellae very large, of complex shape. Minute species (less than 250 μm).
Fam. **Microzetidae** (Genus *Berlesezetes,* see key "B" for species separation)

5(4). Chelicerae without lateral appendage. Usually without complex lamellae. Large species (more than 250 μm).

6(7). A lenticulus present on notogaster. Body wide, usually with fusiform dorsal hairs.
Fam. **Pelopidae** (Genus *Peloptulus, P. phaenotus*)

7(6). Interlamellar hair never leaf-like. Usually no fusiform dorsal hairs present.

8(9). Lamellae very broad, usually meeting or fusing in the middle, mostly covering prodorsum. Fam. **Oribatellidae**

a(b) One pair of anal, and one pair of adanal setae present.
Genus ***Paralamellobates*** (*P. ceylanicus*)

b(a) Two pairs of anal, and two pairs of adanal setae present.
Genus ***Lamellobates*** (*L. hauseri aegypticus*)

9.(8). Lamellae either narrow slats along margin of prodorsum, or, if broader, never meeting in the middle.

10(11). Notogaster with downward-bending true pteromorphae. Legs monodactyl.
Fam. **Haplozetidae**

a(b) Dorsosejugal suture with 3 arches. Pteromorphae and dorsum foveolate.
Genus ***Rostrozetes*** (*R. foveolatus*)

b(a) Dorsosejugal suture without arches. Pteromorpha and dorsum not foveolate.
Genus ***Xylobates*** (*X. capucinus*)

11(10). Notogaster with short, horizontal pteromorphae. Legs tridactyl. Fam. **Oribatulidae**

a(b) Notogaster with 13 or 14 pairs of setae. Translamella present.
Genus ***Zygoribatula*** (*Z. cognata*)

b(a) Notogaster with 10 or 15 pairs of setae. Translamella absent.

c(d) Pteromorphae present. Genus ***Scheloribates*** (see key C for species separation)

d(c) Pteromorphae absent. Genus ***Oribatula*** (*O. tibialis*)

12(13). Notogaster very broad, more broad than long. Areae porosae $A_2$ and $A_3$ either very long and ribbon-like, or divided into several round portions.
Fam. **Mochlozetidae** (Genus *Unguizetes, U. reticulatus*)

13(12). Notogaster more long than broad. Areae porosae $A_2$ and $A_3$ not long or ribbon-like, not divided. Fam. **Ceratozetidae** (Genus *Hypozetes H. translamellatus saudicus*)

14(1). Notogaster without pteromorphae.

15(16). Poronotic animals (2–6 pairs of areae porosae).
Fam. **Passalozetidae** (Genus *Passalozetes, P. nitidus*)

16(15). Pycnonotic animals, i.e. areae porosae, sacculi, or pori absent.
17(20). True lamellae present, bearing lamellar hairs on their apices.
18(19). Interlamellar hairs of moderate length. Fam. **Carabodidae** (Genus *Carabodes, C. reticulatus)*
19(18). Interlamellar hairs minute or absent.
Fam. **Tectocepheidae** (Genus *Tectocepheus,* see key D for species separation)
20(17). No true lamellae; at most narrow costulae present.
21(22). Notogaster with a pair of lateral tubes.
Fam. **Hermanniellidae** (Genus *Hermanniella, H. septentrionalis)*
22(21). Notogaster without lateral tubes.
23(26). More than 4 pairs of hairs on ventral plate.
24(25). Notogaster with 4 semicircular depressions.
Fam. **Dameolidae** (Genus *Fosseremus* see key E for species separation)
25(24). Notogaster without depressions.
Fam. **Eremulidae** (Genus *Eremulus, E. flagellifer)*
26(23). Ventral plate with only 4 pairs of hairs.
Fam. **Oppiidae**
a(d) Costula short, crista are not always present.
b(c) Notogastral setae phylliform. Notogaster with fine parallel lines.
Genus ***Striatoppia*** *(S. niliaca)*
c(b) Notogastral setae not dilated. Notogaster without any lines. Genus ***Oppiella*** *(O. nova)*
d(a) Costula absent, crista absent. Genus ***Oppia*** (see key F for species separation)

## Identification keys to species level of certain genera, represented by more than one species, of the suborder Euoribatida

### A. Key to species of the genus *Galumna*

1(4). Area porosa Aa elongated; interlamellar seta long.
2(3). Sensillus smooth, with a slightly thickened head. ***G. arabica***
3(2). Sensillus barbed, setiform and very long. ***G. flagellata***
4(1). Area porosa Aa circular; interlamellar seta represented by its alveolus. ***G. flabellifera***

### B. Key to species of the genus *Berlesezetes*

1(2). Lamellar apophyses with hook-like projections. Sensillus uniformly barbed on both sides. ***B. auxiliaris***
2(1). Lamellar apophyses crescent-shaped, without any projections. Sensillus with fewer number of barbs on its inner side. ***B. kingi***

### C. Key to species of the genus *Scheloribates*

1(4). Translamella absent.
2(3). Pteromorphae wide; notogastral setae well-developed. ***S. laevigatus***
3(2). Pteromorphae wide, notogastral setae represented by their alveoli only. ***S. pallidulus***
4(1). Incomplete translamella present.

5(6). Notogastral setae well-developed; body narrow. *S. fimbriatus africanus*
6(5). Notogastral setae represented by their alveoli; body wide. *S. saudicus*

### D. Key to species of the genus *Tectocepheus*

1(2). Lamellar cusps pointed, gradually sloping towards translamella. *T. velatus*
2(1). Lamellar cusps with rounded inner edges. *T. sarekensis*

### E. Key to species of the genus *Fosseremus*

1(2). Sensillus suddenly ends with a thickened head. Rostral setae shorter than lamellar ones. *F. laciniatus*
2(1). Sensillus gradually ends with a thickened head. Rostral setae as long as lamellar ones. *F. quadripertitus*

### F. Key to species of the genus *Oppia*

1(14). Notogastral setae not branched.
2(13). Translamella absent.
3(8). Notogastral setae simple, smooth.
4(5). Body cylindrical. *O. cylindrica*
5(4). Body circular or ovoid.
6(7). Interlamellar setae longer than lamellar ones. *O. concolor*
7(6). Interlamellar setae shorter than lamellar ones. *O. clavipectinata*
8(3). Notogastral setae barbed.
9(12) Notogastral setae bilaterally barbed.
10(11). Interlamellar setae about half length of lamellar ones; sensillus short. *O. varians*
11(10). Interlamellar setae about ⅔ length of lamellar ones; sensillus long. *O. arcidiaconoae*
12(9). Notogastral setae unilaterally barbed. *O. fasciata*
13(2). Translamella present. *O. foveolata*
14(1). Notogastral setae bifid. *O. bifidus*

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# The Terrestrial Isopods (Oniscidea) of the Arabian Peninsula

**F. Ferrara, S. Taiti**

Abstract: Seventeen species of terrestrial Isopoda from the Arabian Peninsula are listed. All the species but the cosmopolitan *Porcellionides pruinosus* (Brandt, 1833) and the littoral *Tylos maindroni* Giordani Soika, 1954 are illustrated. Four species are described as new: *Periscyphis barnardi, P. buettikeri, Somalodillo paeninsulae* and *Koweitoniscus rostratus.* The following synonymies are proposed: *Periscyphis chindeensis* Barnard, 1932 = *P. vittatus* Omer-Cooper, 1926; *Koweitoniscus ahmadii* Vandel, 1975 = *K. tamei* (Omer-Cooper, 1923). A key for the identification of all the genera and species is given, together with comments on the distribution of the oniscidean fauna of the Arabian Peninsula.

Keywords: Crustacea, Isopoda, Oniscidea, taxonomy, zoogeography, Arabian Peninsula.

متساويات الأرجل (Oniscidea) في شبه
الجزيرة العربية

ف . فيرارا و س . تياتي

خلاصة : تم تسجيل سبعة عشر نوعا من متساوية الاقدام البرية في شبه الجزيرة العربية . كذلك ، تم توضيح هذه الأنواع
فيما عدا النوع المعروف عالميا (Porcellionides pruinosus (Brandt, 1833 والنوع Tylos maindroni Giordani Soika, 1954
هذا وقد تم وصف ٤ أنواع جديدة لأول مرة وهي: Periscyphis barnardi و P. buettikeri و Somalodillo paeninsulae و
Koweitoniscus rostratus كذلك أقترح استعمال المترادفات التالية : Periscyphis chindeensis Barnard, 1932
يماثل P. vittatus Omer-Cooper, 1926 Koweitoniscus ahmadii Vandel, 1975 يماثل K. tamei (Omer-Cooper, 1923)
وأعطي مفتاح تصنيفي لجميع الأجناس والانواع في شبه الجزيرة العربية بالاضافة الى ملاحظات حول توزيع هذه المجموعة في
شبه الجزيرة العربية .

## INTRODUCTION

Very little is known about the oniscidean fauna of Saudi Arabia. Only two species, in fact, *Periscyphis granai* Arcangeli, 1929 (Kheirallah 1979a, 1979b) and *Porcellionides pruinosus* (Brandt, 1833) (Ataur-Rahim 1982) are recorded. As far as the overall Arabian Peninsula is concerned, Barnard (1941) reported for the two Yemens *Porcellio yemenensis* n. sp., *Porcellionides pruinosus, Periscyphis granai* var. *arabicus* n., *P. besi* n. sp. and *P. bicoloratus* n. sp., Giordani Soika (1954) for Oman *Tylos maindroni* n. sp., and Vandel (1975) for Kuwait *Koweitoniscus ahmadii* n. sp. To our knowledge, no other author has concerned himself with this area for which, up until now, eight forms were known.

The present contribution, which gives a complete picture of the oniscidean fauna known at present in the Arabian Peninsula, is based on material collected in different parts of Saudi Arabia by Prof. W. Büttiker, Jeddah, and in the Yemen Arab Republic by colleagues and friends of the Museo Zoologico

dell'Università, Florence. In addition, the material studied by Barnard (1941) and by Vandel (1975), deposited at the British Museum (Natural History), London, has been re-examined.

The material studied is deposited at the Naturhistorisches Museum (Basel) and the Museo Zoologico dell'Università (Florence).

In order to facilitate future research and comparisons, all the species except the well-known cosmopolitan *Porcellionides pruinosus* and the littoral *Tylos maindroni* have been illustrated.

Abbreviations used throughout the text:

BM = British Museum (Natural History), London
MF = Museo Zoologico dell'Università, Florence
NHMB = Naturhistorisches Museum, Basel
PDRY = People's Democratic Republic of Yemen
YAR = Yemen Arab Republic.

## SYSTEMATIC ACCOUNT

### Fam. **Tylidae** Milne-Edwards, 1840

#### Genus ***Tylos*** Audouin, 1826

***Tylos maindroni*** Giordani Soika, 1954

*Tylos Maindroni* Giordani Soika, 1954. – Boll. Mus. civ. Venezia *7:* 76, figs 8(1,2), 9, pl. 10 figs 4–5.

Arabian records: Oman: Mascate (Giordani Soika 1954).

Distribution: Only known from the type locality.

Remarks: This halophilic species was described on the basis of a single female specimen. From the description it is difficult to say whether it is a valid species or not. Examination of a large number of specimens, including males, from the type locality is necessary to clarify the taxonomic status of this species.

### Fam. **Trachelipidae** Strouhal, 1953

#### Genus ***Protracheoniscus*** Verhoeff, 1917

***Protracheoniscus inexpectatus*** Schmalfuss & Ferrara, 1978 (figs 1–2)

*Protracheoniscus inexpectatus* Schmalfuss & Ferrara, 1978. – Monitore zool. ital. (N.S.) Suppl. *11:* 80, figs 155–168.

Material examined: Saudi Arabia: 3 ♂♂, 2 ♀♀, Jeddah, leg. W. Büttiker, 24.III.1981 (NHMB).

Distribution: Previously known only from Guinea Bissau: Bolama (Schmalfuss & Ferrara 1978). It has also been recently collected in Senegal: Ile de Gorée (datum ined.).

Remarks: These specimens correspond in all details to the ones from West Africa. Considering the collecting site (Jeddah), the species was probably introduced to Saudi Arabia by human activities.

## Fam. **Porcellionidae** Brandt & Ratzeburg, 1831

### Genus ***Porcellionides*** Miers, 1877

***Porcellionides pruinosus*** (Brandt, 1833)

*Porcellio pruinosus* Brandt, 1833. – Bull. Soc. imp. Nat. Moscow *6:* 181.

*Porcellionides pruinosus.* – Barnard 1941; Br. Mus. (Nat. Hist.). Expedition to South-West Arabia 1937–8, *1* (1941–1957): 59.

*Metoponorthus pruinosus.* – Ataur-Rahim 1982; Pakistan J. Zool. *14:* 248.

Material examined: Saudi Arabia: 2 ♀♀, Riyadh, leg. W. Büttiker, 25.V.1980 (NHMB); 1 ♂, 1 ♀ Baharah (21°26′N 39°29′E), leg. W. Büttiker, 1.IV.1980 (NHMB); 3 ♂♂, 5 ♀♀, Al Khobar (26°17′N 50°12′E), leg. W. Büttiker, 28.VIII.1979 (NHMB). YAR: 1 ♀, San'ā', leg. M. Borri, II.1984 (MF 1526).

Arabian records: Saudi Arabia: Al Haire, Derab, Hufuf, Dammam, Al Kharj and Diriyah (Ataur-Rahim 1982). YAR: San'ā', Al 'Asr (Barnard 1941).

Distribution: Cosmopolitan species of Mediterranean origin.

### Genus ***Porcellio*** Latreille, 1804

***Porcellio yemenensis*** Barnard, 1941 (fig. 3)

*Porcellio yemenensis* Barnard, 1941. – Br. Mus. (Nat. Hist.). Expedition to South-West Arabia 1937–8, *1* (1941–1957): 57, fig. 1.

Material examined: Saudi Arabia: 2 ♀♀, Al Faraah (20°57′N 40°12′E), 1800 m, leg. W. Büttiker, 15.X.1982 (NHMB). YAR: 3 ♂♂, 5 ♀♀, Wadi Maqsala (17°05′N 43°32′E), 26 km WNW of Sa'dah, 2000 m, leg. B. Lanza, M. Borri & M. Poggesi, XI.1979 (MF 275); 2 ♂♂, 3 ♀♀, Wadi Sharawa (17°21′N 43°23′E), leg. M. Borri & M. Poggesi, IX.1980 (MF 974); 1 ♂, Bab el Filak (14°32′N 44°27′E), 2420 m, ca. 10 km E of Dhamar, leg. M. Borri & M. Poggesi, 2.II.1984 (MF 1528); 8 ♂♂, 17 ♀♀, Kawkaban (15°29′N 43°53E), leg. M. Borri & M. Poggesi, 31.I.1984 (MF 1529); 1 ♂, 6 ♀♀, Manakhah (15°04′N 43°45′E), 2300 m, leg. M. Borri & M. Poggesi, 1.II.1984 (MF 1530).

Arabian records: PDRY: Dhala, Jebel Jihaf (Barnard 1941). YAR: Birkat al Bu'r (near Haz), top of Al Errein (near Haz), Jebel Masnah (SW of Ma'bar), top of pass over Jebel Sumara, Ghaiman (Barnard 1941).

Distribution: South-western Arabian Peninsula.

Remarks: These specimens show a great variability in the development of dorsal granulations and frontal lobes (fig. 3a–b), in the shape of telson (fig. 3d–e) and even of the male pleopod 1 exopodite (fig. 3h–i). However, these variations appear to be individual and not to be linked to the different populations.

***Porcellio assimilis*** Strouhal, 1957 (fig. 4)

*Porcellio assimilis* Strouhal, 1957. – Ann. Naturhist. Mus. Wien *61* (1956–57): 305, figs 1–5.

Material examined: Saudi Arabia: 1 ♂, Khashm Khafs (25°36′N 46°27′E), 610 m, leg. W. Büttiker, 20.II.1981 (NHMB).

Distribution: This species was previously collected only in Palestine: Jerusalem and wadi N of Ras Umm Jurfan (Strouhal 1957).

Remarks: This specimen, an adult male 13 mm long, is identified as *P. assimilis*, since it corresponds in all details to Strouhal's description. It is, however, dubious that this species is really distinct from *P. penicilliger* Verhoeff, 1917, and it is possible that the differences observed by Strouhal are mostly due to the inaccuracy of Verhoeff's description.

VANDEL (1980:109) transfers *P. assimilis* to the genus *Trachelipus* Budde-Lund, 1908, and in particular to the *triaculeatus*-group, together with the new species *T. triaculeatus* and *T. curti*. According to the French author, this group is essentially characterized by the presence of three cephalic points in the front. Vandel's opinion is certainly incorrect, since *P. assimilis* has two pairs of pseudotracheae as in *Porcellio*, and not five pairs of respiratory areas as in *Trachelipus*. Moreover, by judging from descriptions and figures, also *T. triaculeatus* and *T. curti* have *Porcellio*-type respiratory structures, and certainly do not belong to the genus *Trachelipus*.

***Porcellio evansi*** Omer-Cooper, 1923 (fig. 5)

*Porcellio (Porcellio) Evansi* OMER-COOPER 1923. – J. Bombay nat. Hist. Soc. *29:* 100, figs 1–11.

Material examined: Saudi Arabia: 1 ♂, 7 ♀♀, Al Khardj (24°21'N 47°11'E), 450 m, leg. A.S. Talhouk, 2.II.1980 (NHMB); 1 ♂, 2 ♀♀, same data (MF 1592).

Distribution: Previously known only from Iraq: Amara (= El Amarah) and Bagdad (OMER-COOPER 1923), and Bagdad (FRANKENBERGER 1939).

Remarks: In some specimens the median lobe of cephalon is divided into three small lobes: a median triangular one and two rounded paramedian ones (fig. 5a); while in other specimens the three lobes are fused together (fig. 5b).

Fam. **Eubelidae** Budde-Lund, 1899

Genus ***Periscyphis*** Gerstaecker, 1873

***Periscyphis vittatus*** Omer-Cooper, 1926 (fig. 6)

*Periscyphis vittatus* Omer-Cooper, 1926. – Proc. zool. Soc. Lond. *24:* 366, figs 23–27.

Material examined: YAR: 6 ♂♂, 14 ♀♀, 4 juvs near Al Mukhā, leg. M. Borri, M. Poggesi & F. Sammicheli, 11.–12.II.1984 (MF 1527).

Distribution: This species has also been recorded from Clavis in Ethiopia (FERRARA 1972), Obock and Djibouti (OMER-COOPER 1926), Bud-Bud, Jesomma, Chisimaio and Fuma Nangue Island in Somalia (FERRARA 1973), and Chinde in Mozambique (BARNARD 1932).

Remarks: Re-examination of the Holotype of *P. chindeensis* Barnard, 1932 from Chinde in Mozambique (BM 1933:1:25:262) revealed the identity of this species and *P. vittatus*.

*P. vittatus* is a sabulicolous and fossorial species. It is easily distinguishable by the lack of lateral thickening and sulcus arcuatus on pereon segment 1, shape of telson and uropods, presence of a tubercle on the male pereopod 7 merus.

***Periscyphis erythraeus*** Ferrara, 1972 (fig. 7)

*Periscyphis erythraeus* Ferrara, 1972. – Monitore zool. ital. (N.S.) Suppl. *4:* 211, figs 2–13.

Material examined: Saudi Arabia: 1 ♂, 1 ♀, W. Horash (21°07'N 40°31'E), 1600 m, leg. W. Büttiker, 4.IV.1980 (MF 1593); 1 ♂, same data (NHMB); 1 ♀, Wadi Daykah (21°15'N 40°08'E), 600 m, leg. W. Büttiker, 4.IV.1980 (NHMB); 1 ♂, Wadi Gaanah (18°26'N 41°53'E), leg. W. Büttiker, 13.–14.II.1980 (NHMB).

Distribution: Previously recorded only from Ethiopia: Adi Caié (FERRARA 1972).

Remarks: *P. erythraeus* is very close to *P. bicoloratus* in the structure of cephalon, pereon segment 1, telson and uropods. It differs in the male by the presence of strong lobes on pereopod 7 merus; triangular instead of ovoid pleopod 1 exopodite which is strongly spinose on the posterior margin; rounded, instead of pointed, apex of pleopod 1 endopodite.

***Periscyphis bicoloratus*** Barnard, 1941 (fig. 8)

*Periscyphis bicoloratus* Barnard, 1941. – Br. Mus. (Nat. Hist.). Expedition to South-West Arabia 1937–8, *1* (1941–1957): 65.

Material examined: PDRY: 3 ♂♂, Dhala, from detritus under succulent plants, 4800 ft, leg. H. Scott, 14.IX.1937 (BM 1949:2:2:85–87, syntypes of *P. bicoloratus*.)

Arabian records: PDRY: Dhala (Barnard 1941).

Distribution: Known only from the type locality.

Remarks: This species was briefly described without any illustrations by Barnard (1941). Reexamination of the syntypes confirms the validity of this species.

***Periscyphis besi*** Barnard, 1941 (fig. 9)

*Periscyphis besi* Barnard, 1941. – Br. Mus. (Nat. Hist.). Expedition to South-West Arabia 1937–8, *1* (1941–1957): 63, fig. 3.

Material examined: PDRY: 4 ♂♂, 8 ♀♀, Jebel Harir, 5000–6000 ft, leg. H. Scott & E.B. Britton, 10.XI.1937 (BM 1949:2:2:73–84, syntypes of *P. besi*).

Arabian records: YAR: 2 miles W of San'ā' (Barnard 1941). PDRY: Jebel Harir, Wadi Dareija und Jebel Jihaf (Barnard 1941).

Distribution: South-western part of Arabian Peninsula.

Remarks: *P. besi* is characterized by the weak development of lateral thickening and shortness of sulcus arcuatus of pereon segment 1, the shape of telson with elongated rectangular distal part and rounded apex, the modification of the male pereopod 7 ischium.

***Periscyphis arabicus*** Barnard, 1941 (fig. 10)

*Periscyphis granai* var. *arabicus* Barnard, 1941. – Br. Mus. (Nat. Hist.). Expedition to South-West Arabia 1937–8, *1* (1941–1957): 59, fig. 2a–g, i (partim: nec specimens from Jebel Harir).

Material examined: YAR: 10 ♂♂, 10 ♀♀, wadi near Majadh (Sa'dah), leg. P. & B. Lanza, M. Borri & M. Poggesi, XI.1979 (MF 269); 4 ♂♂, 6 ♀♀, Wadi Maqsala (17°05'N 43°32'E), about 26 km WNW of Sa'dah, 2000 m, leg. B. Lanza, M. Borri & M. Poggesi, XI.1979 (MF 451); 2 ♀♀, same locality, leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 1 ♀, San'ā', leg. M. Borri & M. Poggesi, VI.–VIII.1981 (MF 1084); 1 ♂ juv., 2 ♀♀, road between San'ā' and Shibe'n (15°31'N 43°54'E), leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 1 ♀, 1 juv., Wadi Sharawa (17°21'N 43°23'E), leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 2 ♀♀, Ju Amlah (17°07'N 43°34'E), about 26 km NW of Sa'dah, 1950 m, leg. M. Borri & M. Poggesi, 6.VII.1981 (MF 1084); 1 ♂, 1 ♀, 7 juvs, Wadi Azzou Valley (17°01'N 43°34'E), leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 1 juv., near L'Anam (17°01'N 43°31'E), leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 1 ♂, Jabal Alab (17°32'N 43°28'E), about 2 km from the border with Saudi Arabia, leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 1 ♂, between Umm Laylah (17°17'N 43°24'E) and Begin (17°24'N 43°27'E), leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 3 juvs, Al Alb (17°31'N 43°25'E), about 23 km N of Begin, leg. M. Borri & M. Poggesi, VI.–VII.1981 (MF 1084); 32 ♂♂, 21 ♀♀, road between Maqsala and L'Anam (17°01'N 43°29'E), leg. M. Borri & M. Poggesi, IX.1980 (MF 1084); 1 ♂, 2 ♀♀, Umm Laylah (17°17'N 43°27'E), about 50 km NW of Sa'dah, 2350 m, leg. B. Lanza, M. Borri & M. Poggesi, 16.XI.1979 (MF 1590); 1 ♀, Khazain Hills (17°01'N 43°37'E), about 17 km NW of Sa'dah, 2000 m, leg. B. Lanza, M. Borri & M. Poggesi, XI.1979 (MF 1591).

Arabian records: YAR: Hada (4 miles SW of San'ā'), Wadi Dhahr (6 miles NW of San'ā'), Bait Baus (6 miles S of San'ā'), Jebel Khol (15 miles N of San'ā'), top of Al Kabar pass (15 miles NW of San'ā'), top of Al Errein (near Haz), Ghaiman (9 miles SE of San'ā'), San'ā' (Barnard 1941). PDRY: Dhala, Jebel Jihaf, Wadi Dareijia (Barnard 1941).

Distribution: South-western part of the Arabian Peninsula.

Remarks: Barnard (1941) considers this form to be a variety of *P. granai* Arcangeli, 1929 from

Ethiopia (Eritrea). The examination of this abundant material and the re-examination of the syntypes of *P. granai* show that *P. arabicus* must be considered a distinct species, even though closely related to *P. granai.* In fact, the differences between the two taxa are constant and significant. In *P. arabicus*, the frontal lamina is folded over vertex, while it is straight in *P. granai;* the lateral margin of pereon segment 1 shows an evident depression which is not present in *P. granai;* the distal part of telson is clearly narrower (cf. fig. 10e and fig. 23 in FERRARA 1972); carpus of the male pereopod 7 lacks the long distal process; the apex of the male pleopod 1 endopodite is straight and pointed, while it is bent outwards and equipped with a rounded hyaline lobe in *P. granai.*

***Periscyphis barnardi*** n. sp. (fig. 11)

*Periscyphis granai* var. *arabicus* Barnard, 1941. – Br. Mus. (Nat. Hist.). Expedition to South-West Arabia 1937–8, *1* (1941–1957): 59, fig. 2h (partim: specimens from Jebel Harir).

Material examined: YAR: 1 ♂ Holotype, 1 ♂, 5 ♀♀ Paratypes, Tes (= Ta'izz), leg. R. Manzoni, 1880 (MF 1588). PDRY: 1 ♂, 2 ♀♀ Paratypes, "Yemen meridionale", leg. E. Dabbene, 27.IV.1884 (MF 1589).

Arabian records: PDRY: Jebel Harir (BARNARD 1941).

Distribution: South-western part of the Arabian Peninsula.

Diagnosis: A species of *Periscyphis* of the *granai*-group, characterized by frontal margin continuous and folded over vertex, lateral margin of pereon segment 1 regularly convex and, in males, by the structure of pereopod 7 with ischium distinctly enlarged and carpus distally with a long rectangular process equipped with two strong terminal spines.

Description: Up to 16 × 6.5 mm (♀). Colour faded by conservation. Dorsum without granulations and with inconspicuous triangular scale-spines. Eye with 23–24 ommatidia arranged in four rows. Cephalon: frontal margin continuous, clearly bent over vertex; interocular line not visible. Pereon segment 1: lateral thickening decreasing and almost disappearing towards the posterior angle; lateral margin regularly convex, without a trace of depression; sulcus arcuatus deep and wide; posterior margin regularly incurvate, angles rounded. Telson: distal part narrow, triangular; apex strictly rounded. Uropod: protopodite quadrangular; posterior margin indented; exopodite small.

Male. – Pereopods 1–3 ischium with some verrucae on sternal margin, carpus and distal part of merus with brushes of recurved spines. Pereopod 7: ischium distally enlarged; merus without specializations; carpus not enlarged, distally with a long rectangular process, equipped with two strong spines, and a small setose process. Pleopod 1: exopodite with rounded medial lobe equipped with many short spines; endopodite ending with a hyaline lamellar lobe. Pleopod 2 as in fig. 11i.

Remarks: *P. barnardi* is very close to *P. arabicus* and *P. granai.* It differs from *P. arabicus* by the (a) absence of depression on lateral margin of pereon segment 1; (b) presence of verrucae on sternal margin of ischium of the male pereopods 1–3; (c) carpus of the male pereopod 7 not enlarged and distally with a long process equipped with two strong spines and a small rounded setose process; (d) apex of the male pleopod 1 endopodite with a large hyaline lobe. It differs from *P. granai* in the (a) frontal lamina folded over vertex; (b) shorter sulcus arcuatus; (c) narrower telson; (d) male pereopod 7 with ischium strongly enlarged (it is not so in *P. granai*), longer and not enlarged carpus with distal process with two strong spines.

The specimens examined here correspond to those from Jebel Harir identified by BARNARD (1941: 62, fig. 2h) as *P. granai* var. *arabicus.* In our opinion, these specimens must also be ascribed to the new species.

***Periscyphis buettikeri*** n. sp. (fig. 12)

? *Periscyphis granai.* – Kheirallah 1979; J. arid Envir. *2:* 51. Kheirallah 1979; J. arid Envir. *2:* 329.

Material examined: Saudi Arabia: 1 ♂ Holotype, 2 ♂♂, 3 ♀♀ Paratypes, Shafa (21°12'N 40°23'E),

230 m, leg. W. Büttiker, 21.XII.1982 (NHMB); 2 ♂♂, 2 ♀♀ Paratypes, Bani Sar (20°12'N 41°27'E), 2180 m, leg. W. Büttiker, 21.II.–7.III.1984 (MF 1594); 1 ♀ Paratype, same data, 25.II.–7.III.1984 (NHMB); 3 ♂♂ Paratypes, same data, 29.II.–7.III.1984 (NHMB); 4 ♀♀ Paratypes, Namas (19°11'N 42°19'E), 2380 m, leg. G. Vogel, XI.1980–II.1981 (NHMB); 2 ♂♂, 4 ♀♀ Paratypes, same data, IV.1980 (NHMB); 1 ♀ Paratype, Wadi Al Amer (18°52'N 42°16'E), 2400 m, leg. W. Büttiker, 18.–19.IX.1983 (NHMB); 1 ♂ Paratype, Wadi Majarish (21°24'N 40°10'E), 1020 m, leg. W. Büttiker, 8.II.1980 (NHMB).

Arabian records: Saudi Arabia: Gebel Al Hadah (about 20 km NW of At-Taif) (KHEIRALLAH 1979a, 1979b).

Distribution: South-western Saudi Arabia.

Diagnosis: A species of *Periscyphis* of the *granai*-group, characterized by the frontal margin interrupted in the middle, by the lateral margin of pereon segment 1 depressed and, in males, by the structure of pereopod 7 with ischium not enlarged, merus with a distinct tubercle and carpus with tergal margin strongly convex.

Description: 13×6 mm (♂ and ♀). Colour variable: usually iron-gray with lateral margins of pereon and pleon epimera, distal part of telson and uropods colourless. Eye with about 23 ommatidia. Cephalon: largely rounded lateral lobes; it lacks a continuous frontal margin, while on both sides the interocular line is present. Pereon segment 1: lateral thickening is considerable, and disappears in the posterior third of the segment, forming on the lateral margin an evident depression; sulcus arcuatus which ends approximately in correspondence with the depression; posterior margin of segment regularly incurved. Telson: distal part triangular, acute apex which does not reach the rear margin of the uropods. Uropod: similar to that of *P. barnardi*, only the exopodite is smaller.

Male. – Pereopods 1–3: ischium with conspicuous verrucae on sternal margin; carpus with brushes of pointed spines; only merus of pereopod 1 with brush of spines on the distal third of the segment. Pereopod 7: ischium not enlarged with sternal margin distinctly sinuous and tergal margin distally truncate, rostral surface distally with a large depression; merus with a big triangular process on rostral surface; carpus curved and with tergal margin strongly convex. Pleopod 1: exopodite with rounded medial lobe; endopodite with pointed apex ending with a conical hyaline lobe. Pleopod 2 as in fig. 12j.

Remarks: *P. buettikeri* belongs to the *granai*-group together with *P. granai*, *P. arabicus* and *P. barnardi*, and it is readily distinguishable from all the species by the absence of a continuous margin across the front, modifications of the male pereopod 7 and structure of the male pleopod 1 endopodite.

It is almost certain that the specimens from Jebel Al-Hadah quoted by KHEIRALLAH (1979a, 1979b) as *P. granai* belong to the new species.

***Periscyphis*** sp. (fig. 13)

Material examined: Saudi Arabia: 2 ♀♀, Wadi Mizbil (24°29'N 46°29'E), 610 m, leg. W. Büttiker, 24.XII.1977 (NHMB).

Remarks: These specimens most probably belong to a new species, considering the structure of cephalon, pereon segment 1 and telson; but lack of males does not allow a safe identification. Nonetheless, they are quoted here because this record represents the limit of the penetration in the Arabian Peninsula of the genus *Periscyphis*.

### Genus ***Somalodillo*** Taiti & Ferrara, 1982

***Somalodillo paeninsulae*** n. sp. (fig. 14)

Material examined: Saudi Arabia: 1 ♀ Holotype, Ras Hatibah (21°56'N 39°01'E), leg. W. Büttiker, VIII.1982 (NHMB).

Diagnosis: A species of *Somalodillo* characterized by claviform scale-spines, frontal lamina slightly folded over vertex, rounded inner lobe of schisma, apex of telson with rounded angles and extreme reduction of uropod exopodites.

Description: 6 × 2.5 mm. Animal able to roll up into a ball. Colour: yellowish brown. Dorsum equipped with elongated claviform scale-spines. Eye with 12–13 ommatidia. Cephalon: frontal lamina slightly folded over vertex, but clearly separated from it. Pereon segment 1: lateral margin thickened, sulcus arcuatus narrow and shallow, posterior margin straight, inner lobe of schisma rounded, protruding slightly backwards in comparison to the outer one. Epimera of pereon segment 2 with a small triangular tooth on ventral surface. Epimera of pereon segment 3 ventrally without tooth (only a slight transversal thickening is present). Telson with short quadrangular distal part, apex truncated with rounded angles. Antenna: second joint of flagellum 1.5 times longer than first. Inner branch of maxillule with two unequal penicils. Pleopod exopodites with denticulated scales; only exopodites 1 and 2 with *Periscyphis*-type pseudotracheae. Uropod: protopodite with medial part depressed and covered by the telson; the exopodite, inserted dorsally, is extremely reduced and only the apical seta is visible.

Remarks: This specimen deserves to be described firstly because it represents a clearly distinct species, although closely resembling the other two species of *Somalodillo, S. squamatus* and *S. pallidus* Taiti & Ferrara, 1982, both from Somalia; and secondly, because it widens considerably the distribution of the genus.

*S. paeninsulae* differs from *S. squamatus* essentially in the (a) elongated, instead of spatuliform, scale-spines; (b) absence of protuberances on vertex; (c) rounded, instead of triangular, inner lobe of schisma; (d) absence of tooth on ventral surface of pereon segment 3; (e) extreme reduction of uropod exopodite. It differs from *S. pallidus* in the (a) longer and narrower scale-spines (cf. fig. 14b and fig. 14 in Taiti & Ferrara 1982); (b) frontal lamina posteriourly not sinuous and not excavated in the middle; (c) telson with posterior angles rounded; (d) uropod exopodite inserted more dorsally and much more reduced.

## Genus ***Koweitoniscus*** Vandel, 1975

### ***Koweitoniscus tamei*** (Omer-Cooper, 1923) (fig. 15)

*Periscyphis* (= *Cercocytonus*) *Tamei* Omer-Cooper, 1923. – J. Bombay nat. Hist. Soc. *29:* 96, pl. 1 figs 1–16.
*Koweitoniscus ahmadii* Vandel, 1975. – Crustaceana *29:* 74, figs 1–3.

Material examined: Kuwait: 4 ♂♂, 6 ♀♀, Al Ahmadi, leg. J. Brebner, 14.XI.1972 (BM 1973:234:10; syntypes of *Koweitoniscus ahmadii*; the specimens have been labelled by Vandel as *Koweitoniscus brebneri*, but they have been published as *K. ahmadii*). Iraq: *16* ♂♂, 14 ♀♀, Amara (= Al Amarah), leg. R.G. Tame, 1918 (BM 1922:5:18:15–34; syntypes of *Periscyphis tamei*).

Arabian records: Kuwait: Al Ahmadi (Vandel 1975).

Distribution: Iraq: Amara (= Al Amarah), Ruz (Omer-Cooper 1923); Basrah region (Ahmed 1974: *P. tamei*). Kuwait.

Remarks: Re-examination of the syntypes of both *Periscyphis tamei* and *Koweitoniscus ahmadii* shows that they belong to the same species. Omer-Cooper (1923) ascribed this species to the genus *Periscyphis*, and afterwards (1926) to the genus *Microcercus* Budde-Lund, 1910. Both the attributions are incorrect (Ferrara 1972), and the institution of the genus *Koweitoniscus* proposed by Vandel (1975) is perfectly justified. In conclusion, the correct systematic status of this species is: *Koweitoniscus tamei* (Omer-Cooper, 1923).

### ***Koweitoniscus rostratus*** n. sp. (fig. 16)

Material examined: Saudi Arabia: 1 ♂ Holotype, 1 ♂ Paratype, Wadi Daykah (21°15′N 40°08′E),

500 m, leg. W. Büttiker, 12.II.1982 (NHMB); 1 ♂ Paratype, Wadi Uqdah (19°33'N 41°06'E), leg. W. Büttiker, 11.–12.II.1980 (MF 1604).

Diagnosis: Cephalon with continuous frontal margin, telson with elongated triangular distal part, uropod protopodites distally indented, carpus of the male pereopod 7 distally with a long triangular process.

Description: 8 × 3.5 mm. Colour grey with yellowish muscle spots, lateral margins of segments colourless. Dorsum without tubercles or granulations, equipped with inconspicuous upright setae. Eye with 20–22 ommatidia. Body convex, epimera of pereon vertical. Cephalon with frontal lamina folded over vertex, clearly separated from it. Pereon segment 1: lateral margin thickened, sulcus arcuatus deep and wide, outer lobe of schisma largely rounded, distinctly protruding backwards compared to the inner one. Epimera of pereon segments 2 and 3 ventrally with transversal thickenings. Telson with an elongated triangular distal part, apex narrowly rounded. Antenna with flagellar joints subequal. Maxillule: outer ramus with simple teeth, inner ramus with two penicils. Only exopodites of pleopods 1 and 2 with *Periscyphis*-type pseudotracheae. Uropod: protopodite with posterior margin deeply indented, exopodite reduced, endopodite not surpassing tip of telson. Pereopods 1–3 carpus with brushes of recurved spines. Pereopod 7: merus with a rounded lobe on rostral surface, carpus distally with a long triangular process on caudal surface. Pleopod 1: exopodite with rounded median lobe; endopodite with rounded apex and a subapical beak-like process. Pleopod 2 as in fig. 16j.

Remarks: The ascription of this species to the genus *Koweitoniscus* is preliminary. *K. rostratus*, in fact, differs from *K. tamei*, the only other species of the genus, by the presence of a continuous margin across the front and by the shape of telson and uropods. On the other hand, in other genera of Eubelidae (i.e. *Periscyphis, Microcercus*), there are species either with a continuous margin across the head or without. In some species of *Microcercus*, the distal part of telson is rectangular, while in others it is triangular. In *Periscyphis*, there are species with very long uropod exopodites (*P. vittatus*), and others with reduced uropod exopodites (*P. buettikeri*). Moreover, all the characters commonly used in defining the genera of the family Eubelidae correspond in *K. tamei* and *K. rostratus*. In conclusion, for the time being, the establishment of a new genus does not appear justified.

*K. rostratus* is readily identified by the carpal process of the male pereopod 7.

## Key to genera and species of terrestrial Isopoda recorded from the Arabian Peninsula

| | | | |
|---|---|---|---|
| 1. | Uropods covered by telson, not visible in dorsal view | ***Tylos (T. maindroni)*** | |
| – | Uropods not covered by telson, visible in dorsal view ........................... | | 2 |
| 2. | Uropod protopodite cylindrical ........................................... | | 3 |
| – | Uropod protopodite lamellar ............................................. | | 7 |
| 3. | All pleopod exopodites with pseudotracheae | ***Protracheoniscus (P. inexpectatus)*** | |
| – | Only pleopod exopodites 1 and 2 with pseudotracheae ........................... | | 4 |
| 4. | Lateral lobes of cephalon reduced; supra-antennal line distinct; posterior margin of pereon segment 1 convex | ***Porcellionides (P. pruinosus)*** | |
| – | Lateral lobes of cephalon well developed; supra-antennal line absent; posterior margin of pereon segment 1 concave | ***Porcellio*** .................. | 5 |
| 5. | Median lobe of cephalon largely rounded | ***P. yemenensis*** | |
| – | Median lobe of cephalon triangular and/or incised ............................. | | 6 |
| 6. | Male pleopod 1 endopodite with long plumose setae at apex | ***P. assimilis*** | |
| – | Male pleopod 1 endopodite without plumose setae at apex | ***P. evansi*** | |

| | | |
|---|---|---|
| 7. | Postero-lateral angles of pereon segment 1 entire **Periscyphis** .......... | 8 |
| – | Postero-lateral angles of pereon segment 1 notched .............................. | 15 |
| 8. | Cephalon with frontal margin continuous across the head ....................... | 9 |
| – | Cephalon with frontal margin absent or interrupted in the middle ................ | 10 |
| 9. | Lateral margin of pereon segment 1 depressed; carpus of the male pereopod 7 distinctly enlarged on tergal margin **P. arabicus** | |
| – | Lateral margin of pereon segment 1 regularly convex, not depressed; carpus of the male pereopod 7 not enlarged, equipped with a conspicuous distal process **P. barnardi** | |
| 10. | Pereon segment 1 without sulcus arcuatus and lateral thickening .................. | 11 |
| – | Pereon segment 1 with more or less developed sulcus arcuatus and lateral thickening . | 13 |
| 11. | Posterior margin of pereon segment 1 concave, postero-lateral angles subacute **P. vittatus** | |
| – | Posterior margin of pereon segment 1 straight, postero-lateral angles largely rounded . | 12 |
| 12. | Merus of the male pereopod 7 with strong sexual modifications; male pleopod 1 exopodite with a row of spines on posterior margin, endopodite with rounded apex **P. erythraeus** | |
| – | Merus of the male pereopod 7 without apparent sexual modifications; male pleopod 1 exopodite without spines on posterior margin, endopodite with pointed apex **P. bicoloratus** | |
| 13. | Lateral margin of pereon segment 1 depressed; telson with pointed apex **P. buettikeri** | |
| – | Lateral margin of pereon segment 1 regularly convex, not depressed; telson without pointed apex ............................................................ | 14 |
| 14. | Sulcus arcuatus visible only at the anterior angles of pereon segment 1; telson with very long rectangular distal part **P. besi** | |
| – | Sulcus arcuatus visible for more than half the length of pereon segment 1; telson with short triangular distal part **Periscyphis** sp. | |
| 15. | Telson with distal part rectangular ***Somalodillo (S. paeninsulae)*** | |
| – | Telson with distal part triangular **Koweitoniscus** | |
| 16. | Cephalon with a continuous margin across the front; posterior margin of uropod protopodite deeply indented **K. rostratus** | |
| – | Cephalon without a continuous margin across the front; posterior margin of uropod protopodite not indented **K. tamei** | |

## ZOOGEOGRAPHIC COMMENTS

At present, the list of the Oniscidea from the Arabian Peninsula is as follows:

1. *Tylos maindroni* Giordani Soika, 1954;
2. *Protracheoniscus inexpectatus* Schmalfuss & Ferrara, 1978;
3. *Porcellionides pruinosus* (Brandt, 1833);
4. *Porcellio yemenensis* Barnard, 1941;
5. *Porcellio assimilis* Strouhal, 1957;
6. *Porcellio evansi* Omer-Cooper, 1923;
7. *Periscyphis vittatus* Omer-Cooper, 1926;
8. *Periscyphis besi* Barnard, 1941;
9. *Periscyphis erythraeus* Ferrara, 1972;

10. *Periscyphis bicoloratus* Barnard, 1941;
11. *Periscyphis arabicus* Barnard, 1941;
12. *Periscyphis barnardi* n. sp.;
13. *Periscyphis buettikeri* n. sp.;
14. *Periscyphis* sp.;
15. *Somalodillo paeninsulae* n. sp.;
16. *Koweitoniscus tamei* (Omer-Cooper, 1923);
17. *Koweitoniscus rostratus* n. sp.

This list is certainly not complete (almost nothing is known, for instance, about the littoral forms surely present along the coast), but it can be reasonably assumed to be indicative of the oniscidean fauna of the area.

The recorded distribution of each species in the Arabian Peninsula is shown in fig. 17. Most of the records are concentrated in the south-western mountainous part of the peninsula which is ecologically the most favourable for the establishment and flourishing of these arthropods.

According to their distribution, the species, excluding the halophilic and insufficently known *Tylos maindroni,* can be grouped as follows:

a) species introduced by human activities: *Porcellionides pruinosus* and *Protracheoniscus inexpectatus*;

b) species in common with Middle East and/or Mesopotamia: *Porcellio assimilis, P. evansi* and *Koweitoniscus tamei;*

c) species in common with Ethiopia and/or Somalia: *Periscyphis vittatus* and *P. erythraeus;*

d) endemics: *Porcellio yemenensis, Periscyphis besi, P. bicoloratus, P. arabicus, P. barnardi, P. buettikeri, Somalodillo paeninsulae, Koweitoniscus rostratus,* and perhaps *Periscyphis* sp. This group represents about half of the species; but it should be observed that the oniscidean fauna of the surrounding areas is still poorly known, and it is quite possible that this group is less conspicuous. It is certain, nonetheless, that the degree of endemism is low as all the species – perhaps with the exception of *Koweitoniscus rostratus* – are very close to forms inhabiting the Middle East (*Porcellio yemenensis*), Ethiopia and Somalia (*Periscyphis* species and *Somalodillo paeninsulae*).

As regards the composition and origin of this fauna, excluding *Porcellionides pruinosus* and *Protracheoniscus inexpectatus* introduced by man and the littoral *Tylos maindroni,* Arabian terrestrial Isopods are composed of two different elements: one Palearctic (the species of the genus *Porcellio*), which represents approximately 20% of the population; and one Afrotropical (the Eubelidae), which represents by far the more conspicuous part (about 70%). The genus *Porcellio* includes more than 150 species (Gruner 1966:255). The autocthone species occur in Europe, northern Africa and western Asia. The three species of *Porcellio* of the Arabian Peninsula are, as we have said, identical or very similar to forms present in the Middle East. As regards the Eubelids, an enormous family spread out almost exclusively in tropical Africa, three genera populate the Arabian Peninsula: *Periscyphis, Somalodillo* and *Koweitoniscus.* The first includes about 30 species concentrated for the most part in East Africa and in the south-western part of the Arabian Peninsula. Two species, *P. convexus* (Budde-Lund, 1885) and *P. albescens* (Budde-Lund, 1885), have penetrated along the Nile Valley as far as northern Egypt. It is interesting to note that the forms of the Arabian Peninsula are the same or very similar to the ones present in the coastal part of Ethiopia and northern Somalia, and that the genus *Periscyphis* by itself represents 50% of the population of the Arabian isopods. *Somalodillo,* as *Periscyphis,* is a typical element of East Africa. In fact, in addition to *S. paeninsulae*, it includes *S. squamatus* and *S. pallidus,* both from Somalia. *Koweitoniscus* is, together with *Saidjahus* Budde-Lund, 1904 from the Oriental Region, the only genus of the family Eubelidae that is not found in Africa. However, its similarities to the genera *Periscyphis* and *Somalodillo* are evident.

## ACKNOWLEDGEMENTS

We are grateful to Prof. W. Büttiker (Jeddah) for the loan of the material collected in Saudi Arabia; to Prof. B. Lanza, Director of the Museo Zoologico dell'Università (Florence), for the material collected by Drs M. Poggesi and M. Borri in the Yemen Arab Republic. Our thanks are also due to Dr. R. Lincoln and Miss J.P. Ellis for the loan of type-material deposited at the British Museum (Natural History), London.

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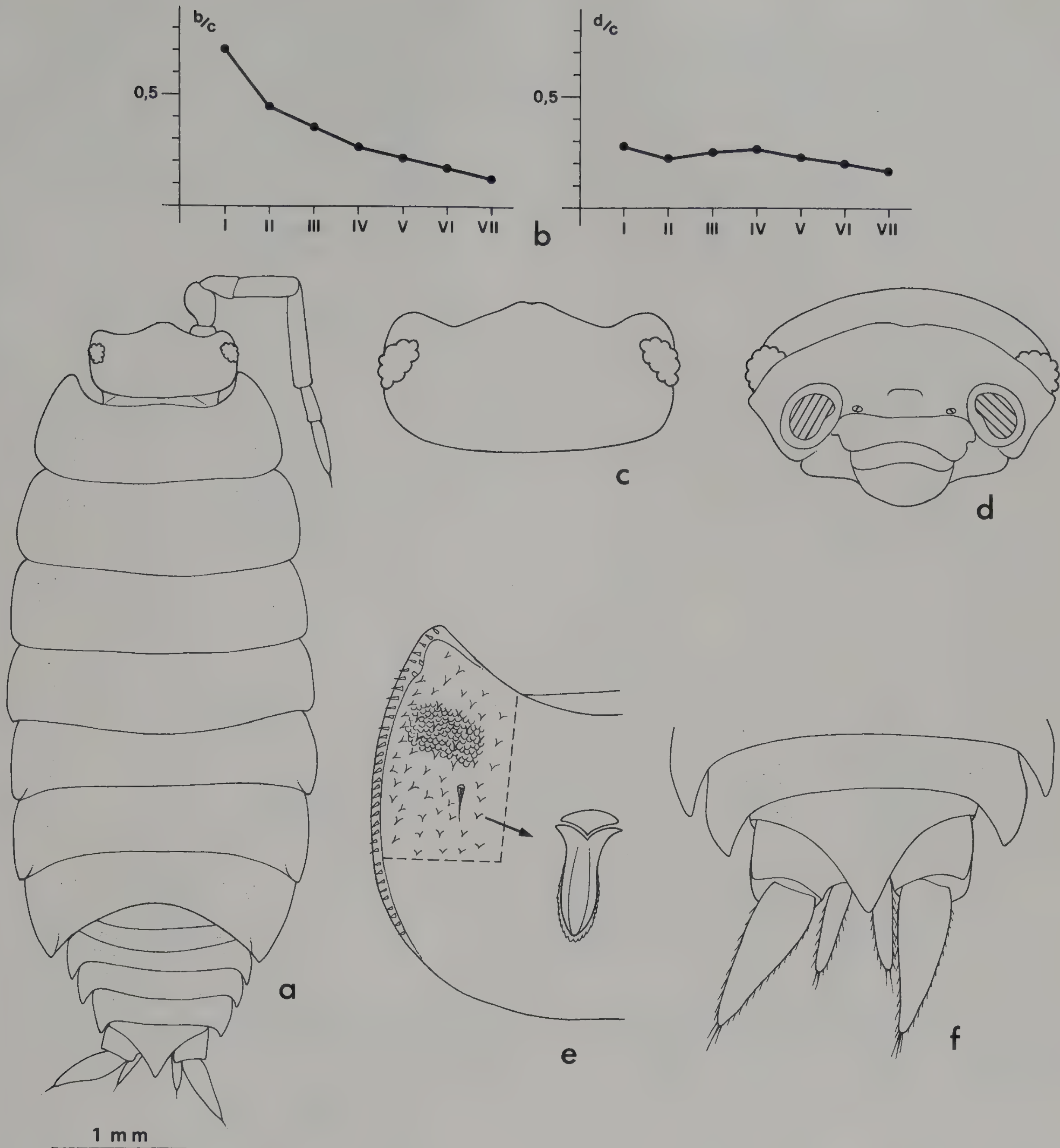


Fig. 1: *Protracheoniscus inexpectatus* Schmalfuss & Ferrara, 1978; a, adult female; b, co-ordinates of noduli laterales; c, cephalon, dorsal view; d, cephalon, frontal view; e, epimeron of pereon segment 1; f, pleon segments 4–5, telson and uropods.

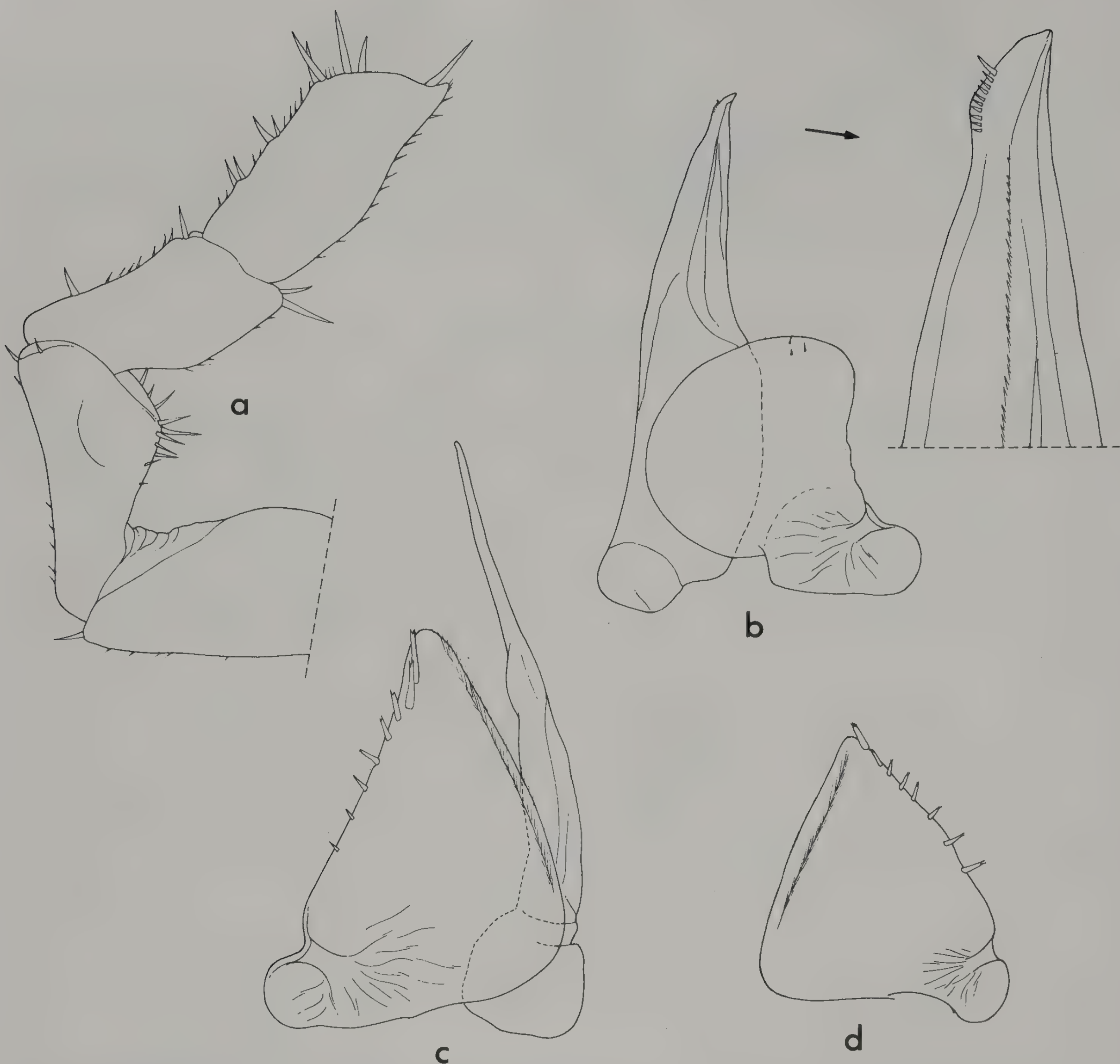


Fig. 2: *Protracheoniscus inexpectatus* Schmalfuss & Ferrara, 1978, ♂: a, pereopod 7; b, pleopod 1; c, pleopod 2; d, pleopod 5 exopodite.

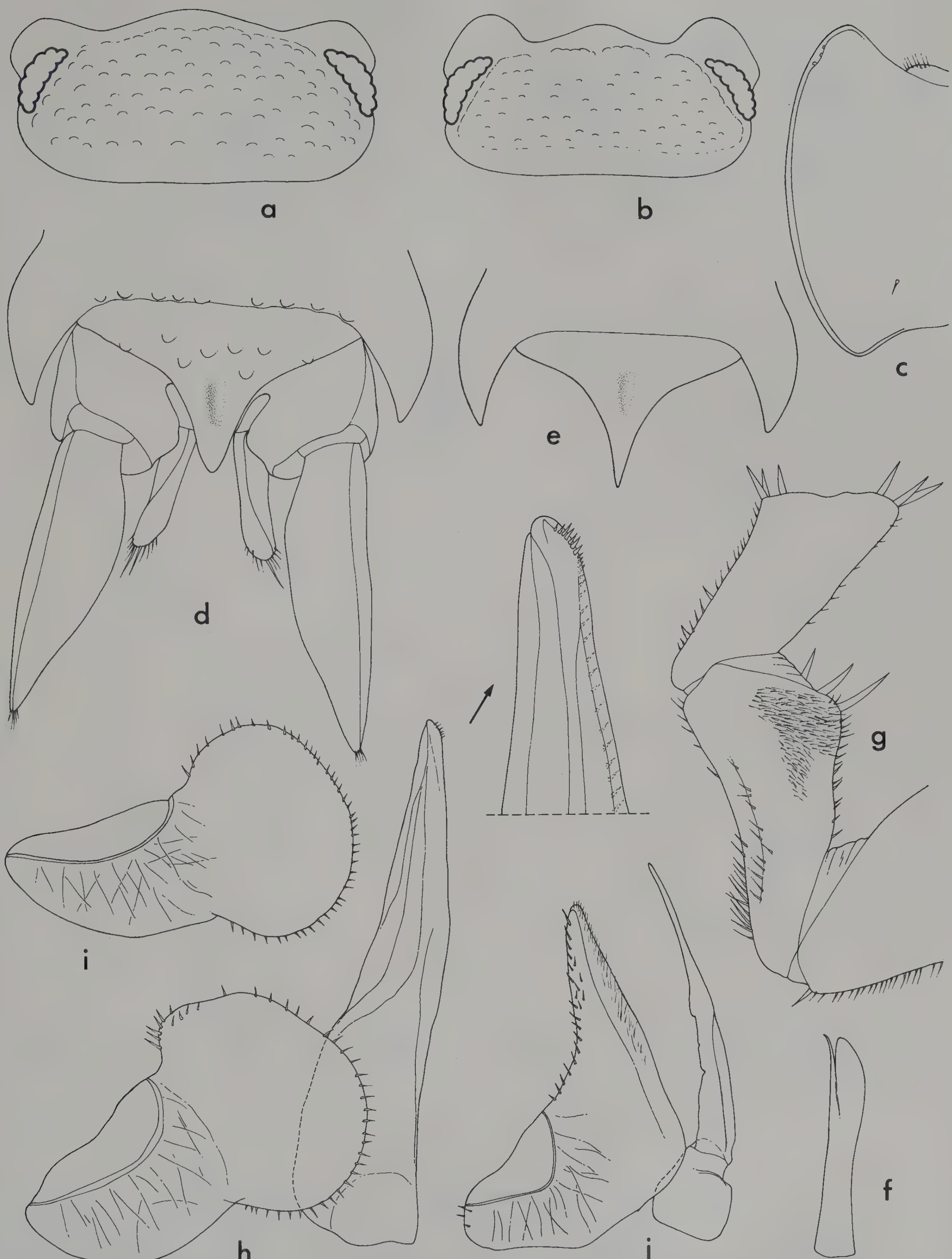


Fig. 3: *Porcellio yemenensis* Barnard, 1941: a, b, cephalon, dorsal view; c, epimeron of pereon segment 1; d, pleon segment 5, telson and uropods; e, pleon segment 5 and telson of another specimen; f, spine of sternal margin of pereopod 1–3 carpus ♂; g, pereopod 7 ♂; h, pleopod 1 ♂; i, pleopod 1 exopodite ♂ of another specimen; j, pleopod 2 ♂.

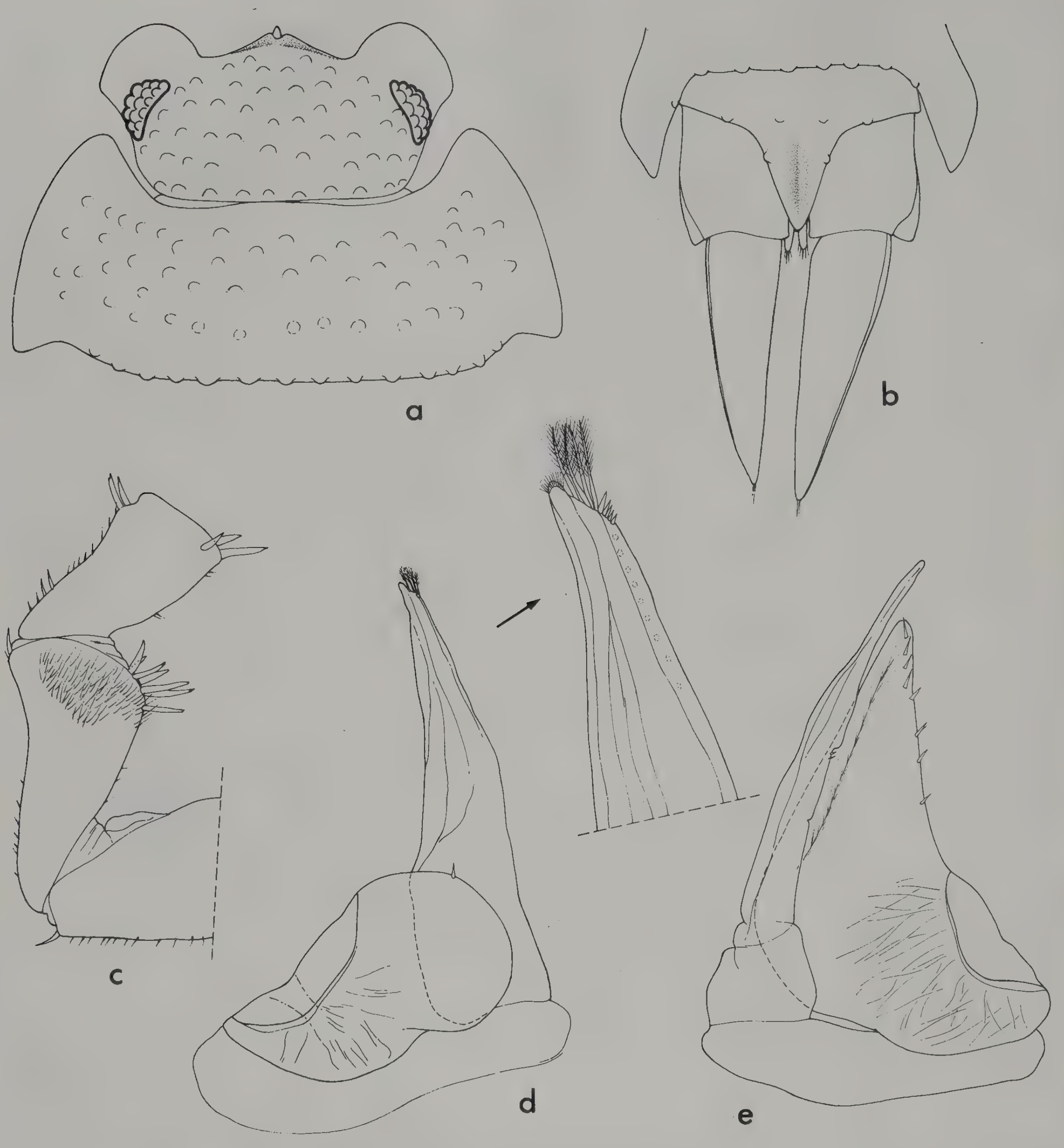


Fig. 4: *Porcellio assimilis* Strouhal, 1957, ♂: a, cephalon and pereon segment 1; b, pleon segment 5, telson and uropods; c, pereopod 7; d, pleopod 1; e, pleopod 2.

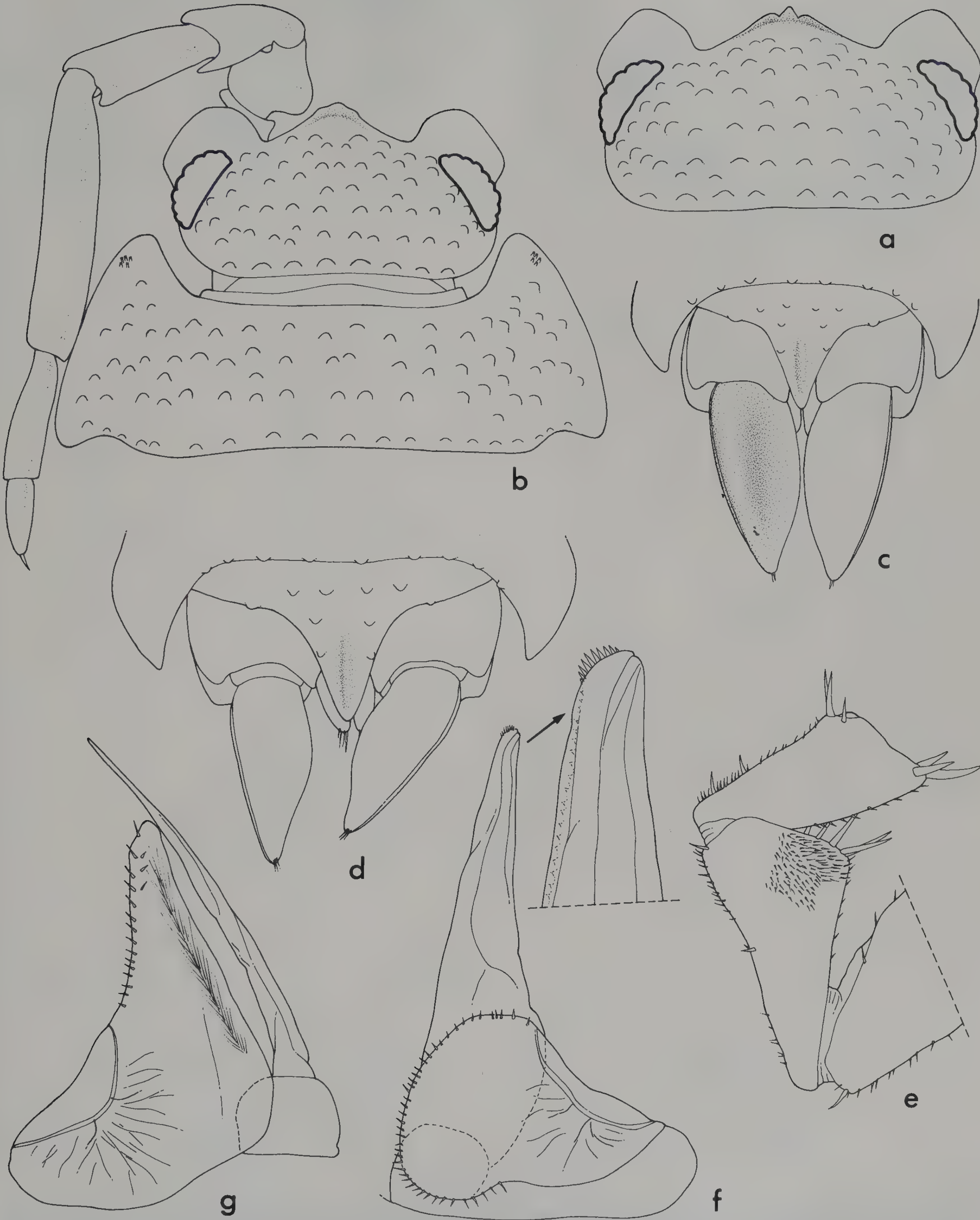


Fig. 5: *Porcellio evansi* Omer-Cooper, 1923: a, cephalon, dorsal view; b, cephalon, pereon segment 1 and left antenna; c, pleon segment 5, telson and uropods ♂; d, pleon segment 5, telson and uropods ♀; e, pereopod 7 ♂; f, pleopod 1 ♂; g, pleopod 2 ♂.

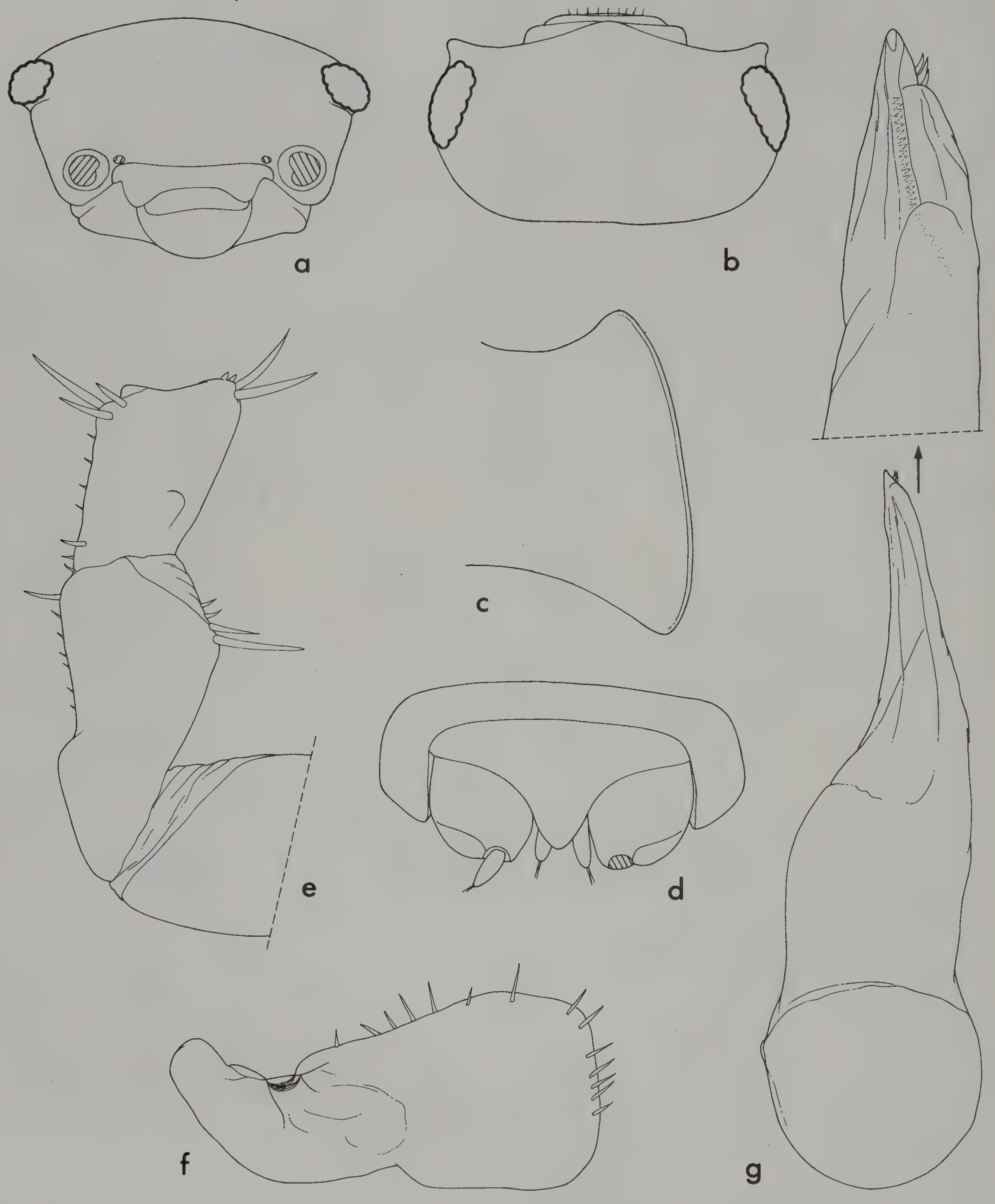


Fig. 6: *Periscyphis vittatus* Omer-Cooper, 1926, ♂: a, cephalon, frontal view; b, cephalon, dorsal view; c, epimeron of pereon segment 1; d, pleon segment 5, telson and uropods; e, pereopod 7; f, pleopod 1 exopodite; g, pleopod 1 endopodite.

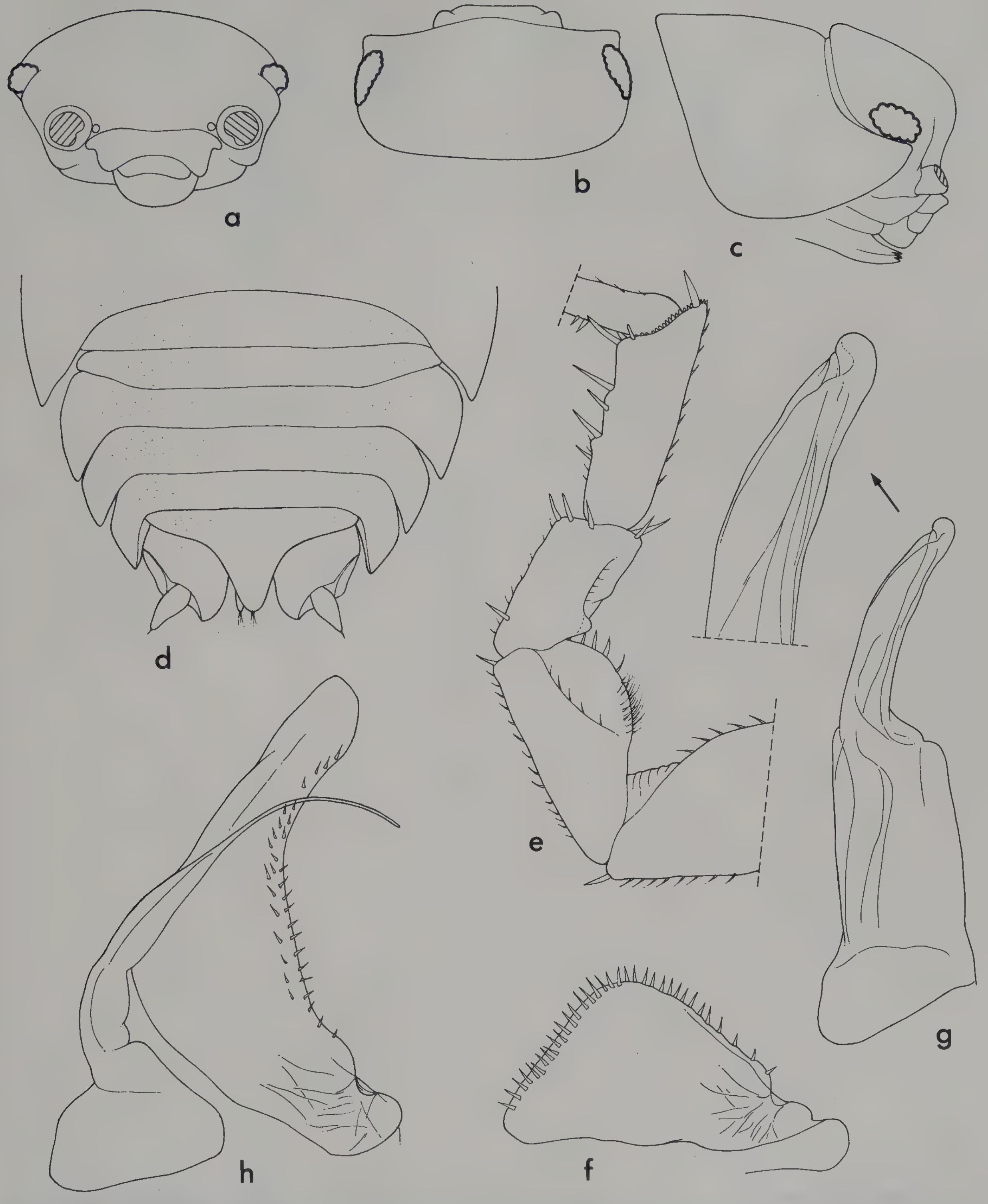


Fig. 7: *Periscyphis erythraeus* Ferrara, 1972, ♂: a, cephalon, frontal view; b, cephalon, dorsal view; c, cephalon and pereon segment 1, lateral view; d, pereon segment 7, pleon, telson and uropods; e, pereopod 7; f, pleopod 1 exopodite; g, pleopod 1 endopodite; h, pleopod 2.

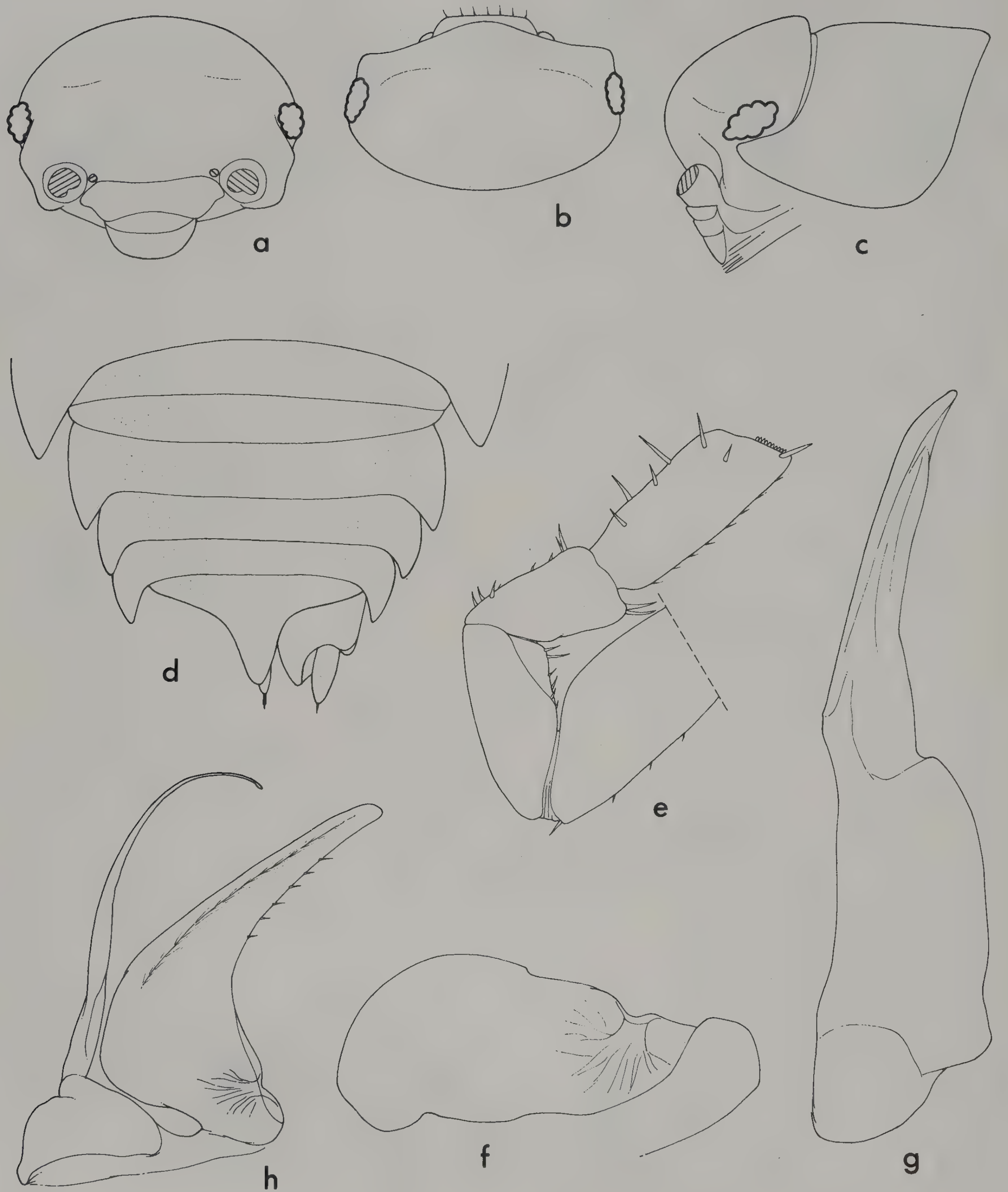


Fig. 8: *Periscyphis bicoloratus* Barnard, 1941, ♂: a, cephalon, frontal view; b, cephalon, dorsal view; c, cephalon and pereon segment 1, lateral view; d, pereon segment 7, pleon, telson and right uropod; e, pereopod 7; f, pleopod 1 exopodite; g, pleopod 1 endopodite; h, pleopod 2.

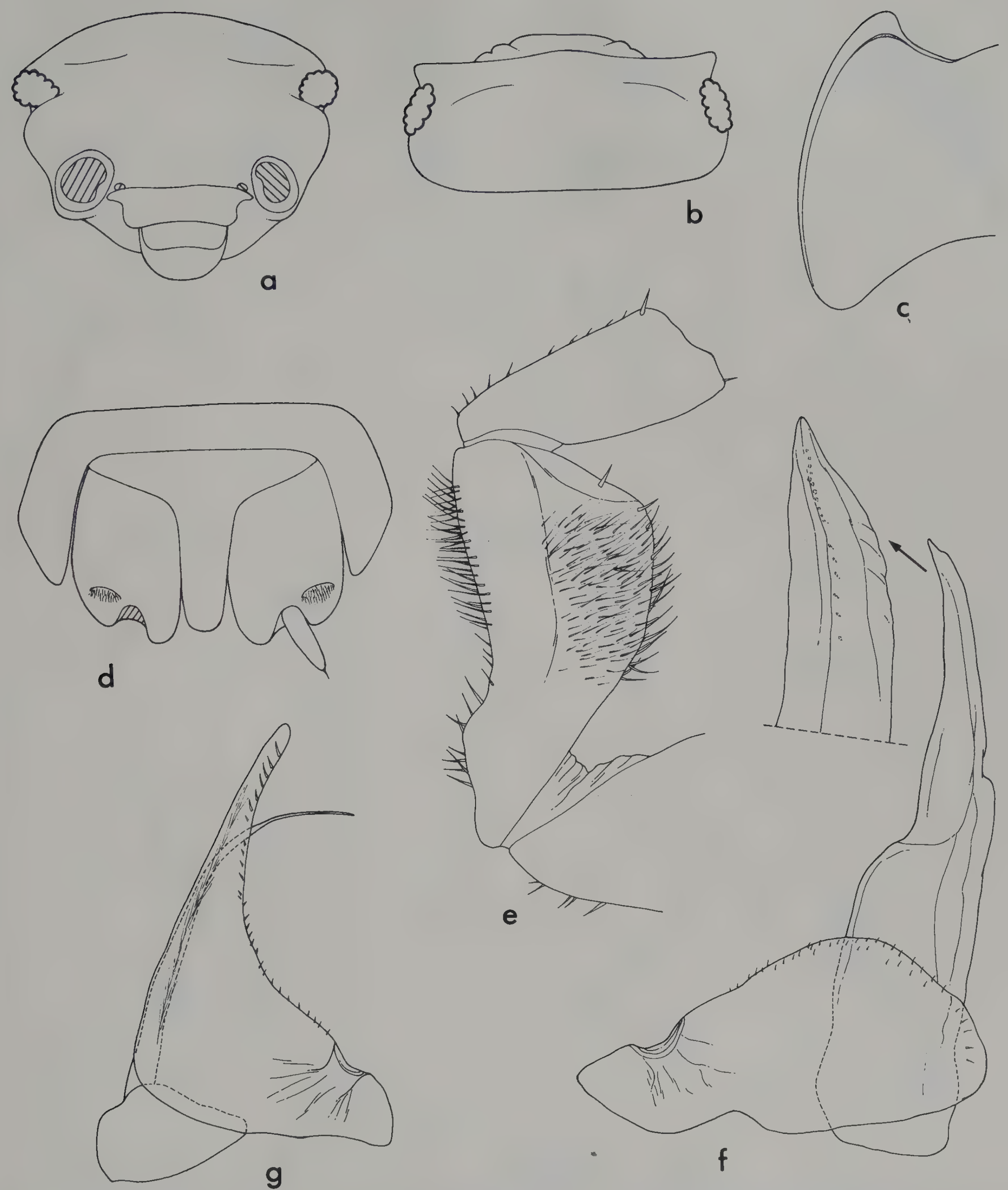


Fig. 9: *Periscyphis besi* Barnard, 1941, ♂: a, cephalon, frontal view; b, cephalon, dorsal view; c, epimeron of pereon segment 1; d, pleon segment 5, telson and uropods; e, pereopod 7; f, pleopod 1; g, pleopod 2.

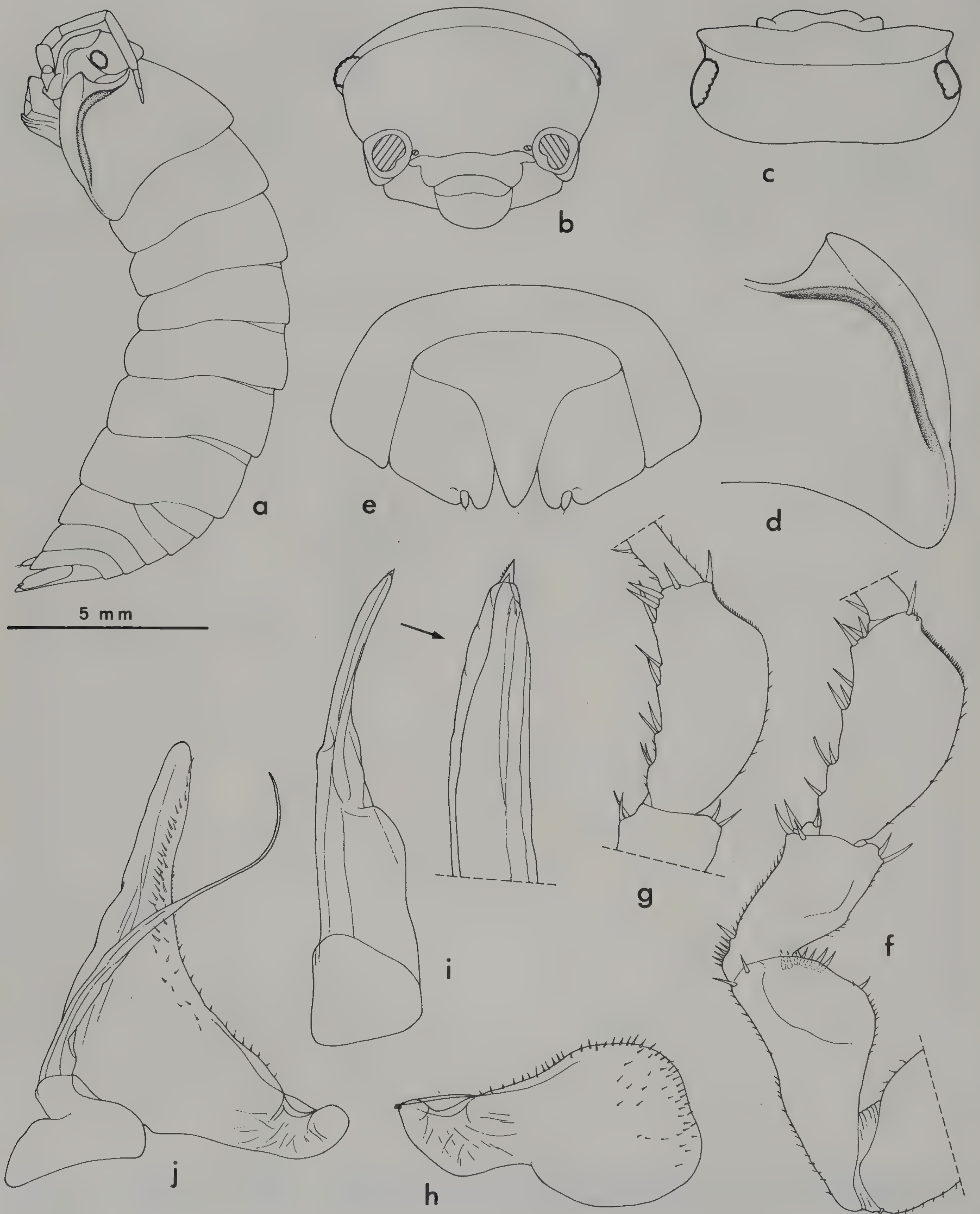


Fig. 10: *Periscyphis arabicus* Barnard, 1941, ♂: a, adult specimen, lateral view; b, cephalon, frontal view; c, cephalon, dorsal view; d, epimeron of pereon segment 1; e, pleon segment 5, telson and uropods; f, pereopod 7, rostral surface; g, pereopod 7 carpus, caudal surface; h, pleopod 1 exopodite; i, pleopod 1 endopodite; j, pleopod 2.

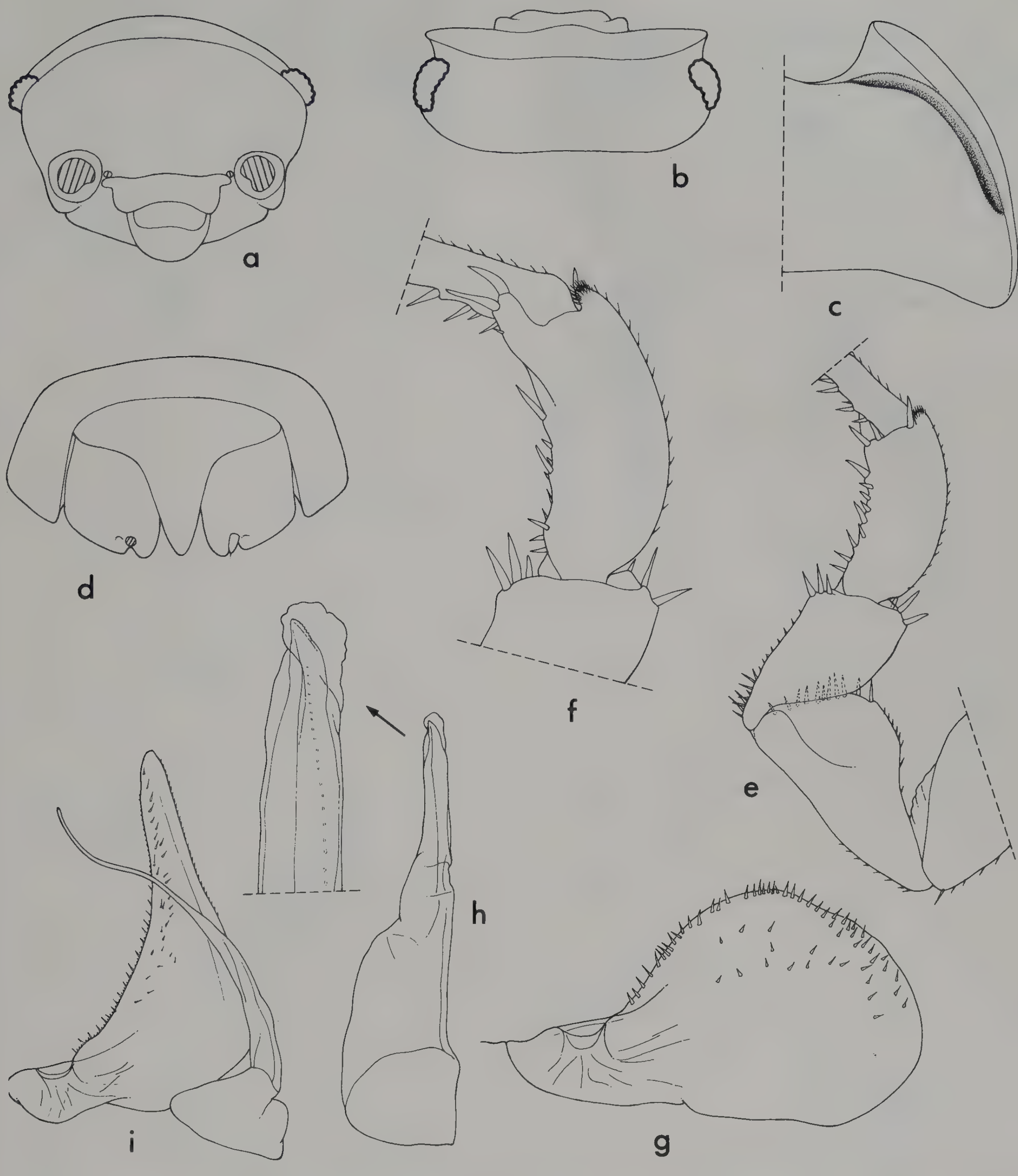


Fig. 11: *Periscyphis barnardi* n. sp., ♂: a, cephalon, frontal view; b, cephalon, dorsal view; c, epimeron of pereon segment 1; d, pleon segment 5, telson and uropods; e, pereopod 7, rostral surface; f, pereopod 7 carpus, caudal surface; g, pleopod 1 exopodite; h, pleopod 1 endopodite; i, pleopod 2.

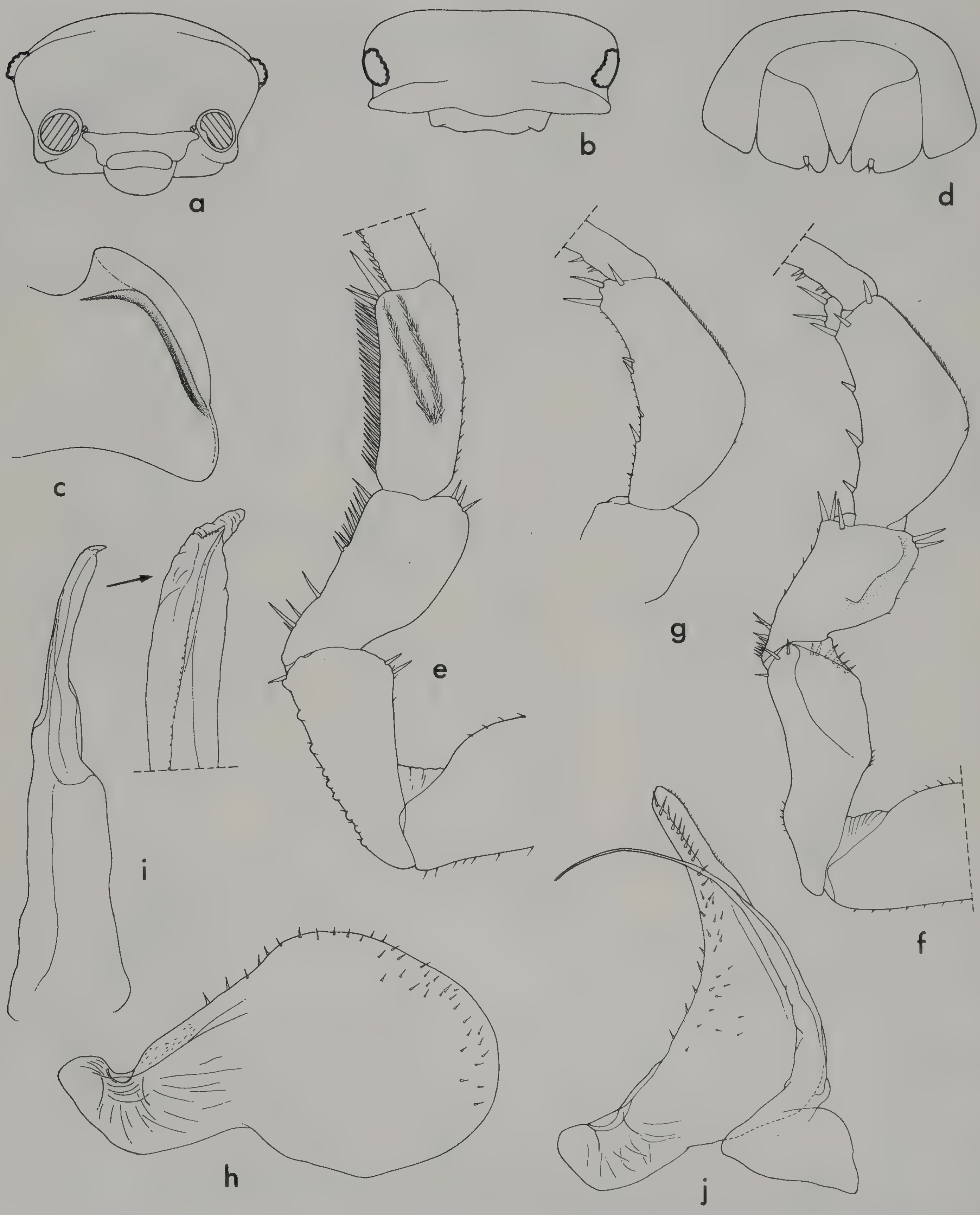


Fig. 12: *Periscyphis buettikeri* n. sp., ♂: a, cephalon, frontal view; b, cephalon, dorsal view; c, epimeron of pereon segment 1; d, pleon segment 5, telson and uropods; e, pereopod 1; f, pereopod 7, rostral surface; g, pereopod 7 carpus, caudal surface; h, pleopod 1 exopodite; i, pleopod 1 endopodite; j, pleopod 2.

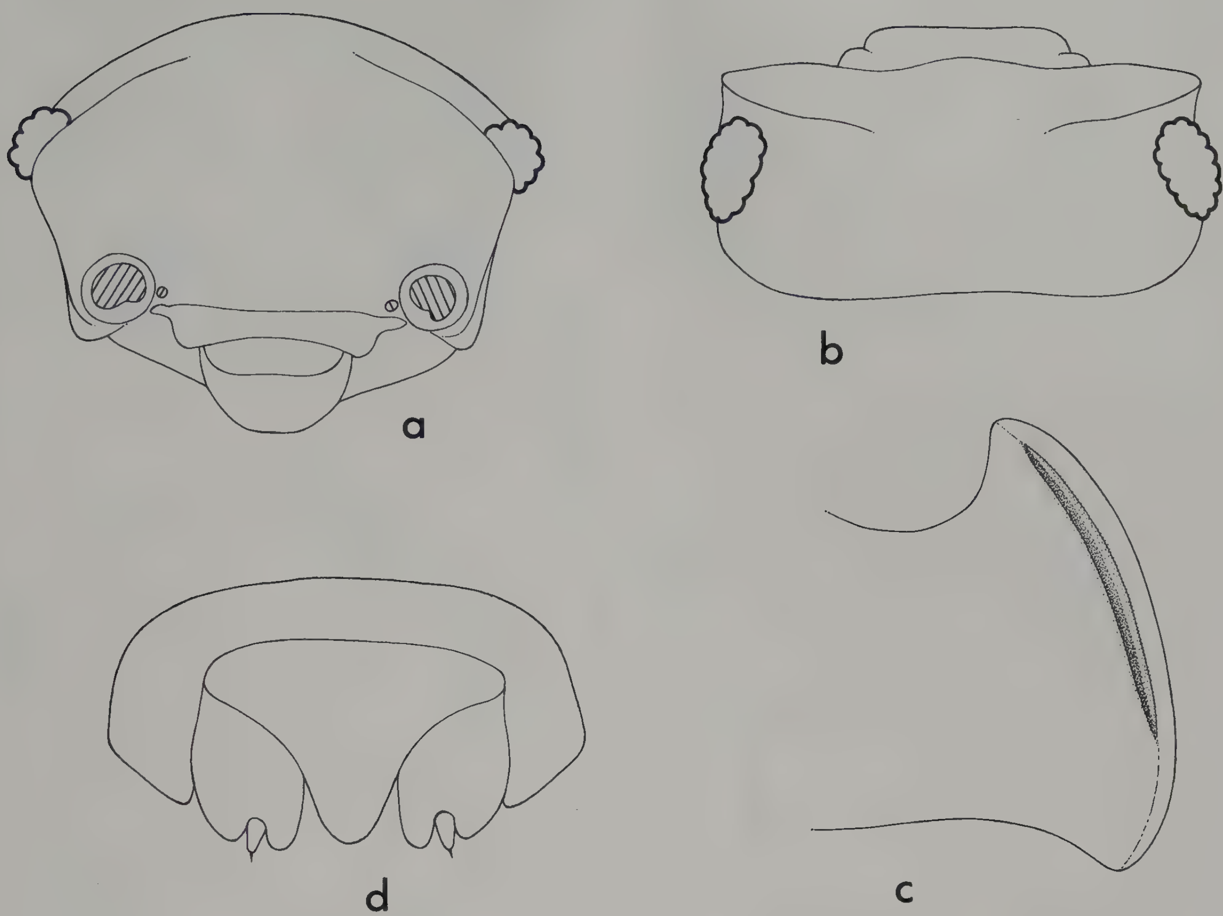


Fig. 13: *Periscyphis* sp.: a, cephalon, frontal view; b, cephalon, dorsal view; c, epimeron of pereon segment 1; d, pleon segment 5, telson and uropods.

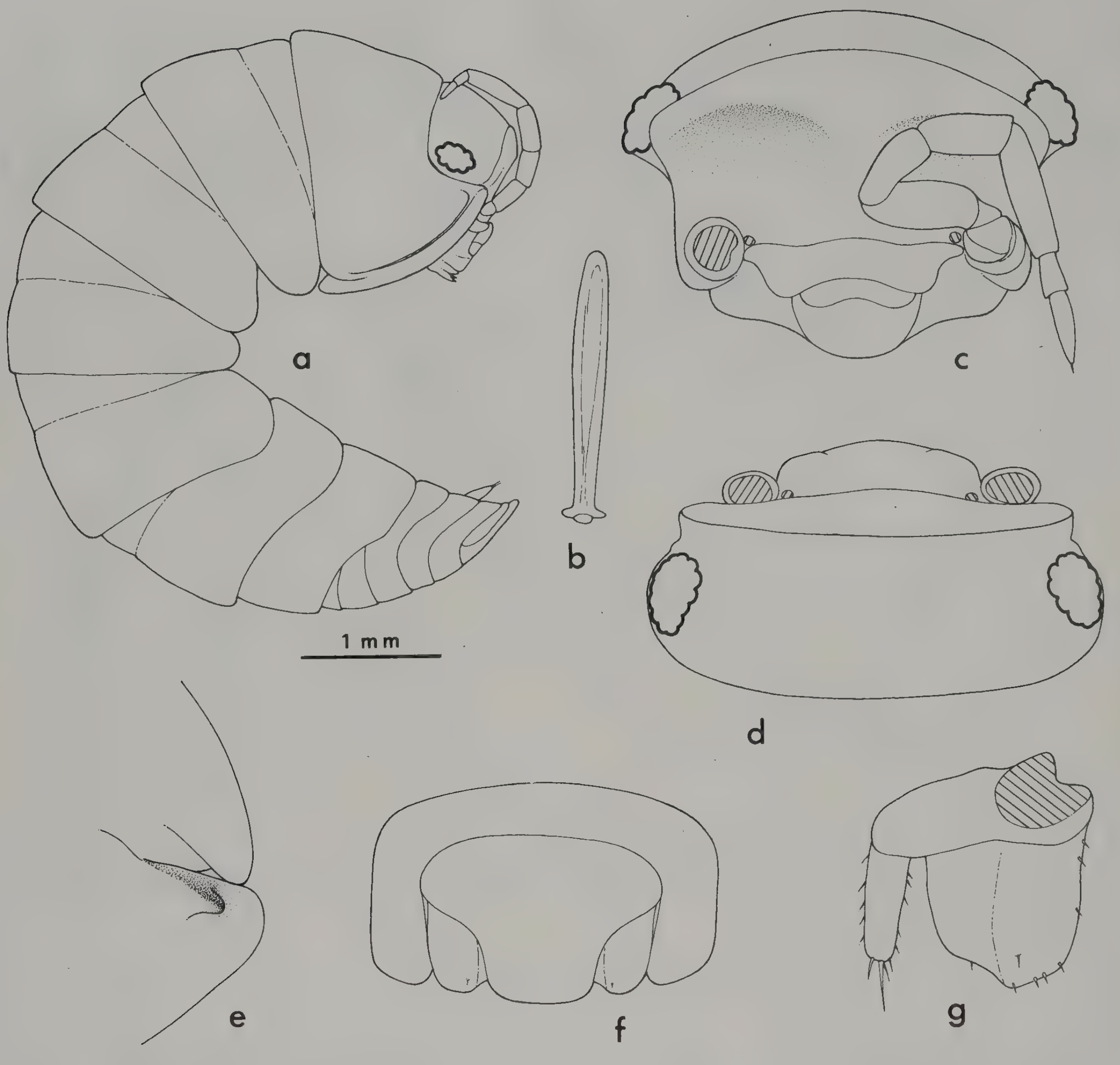


Fig. 14: *Somalodillo paeninsulae* n. sp.: a, adult specimen, lateral view; b, scale-spine; c, cephalon and left antenna, frontal view; d, cephalon, dorsal view; e, epimera of pereon segments 1–2, ventral view; f, pleon segment 5, telson and uropods; g, uropod.

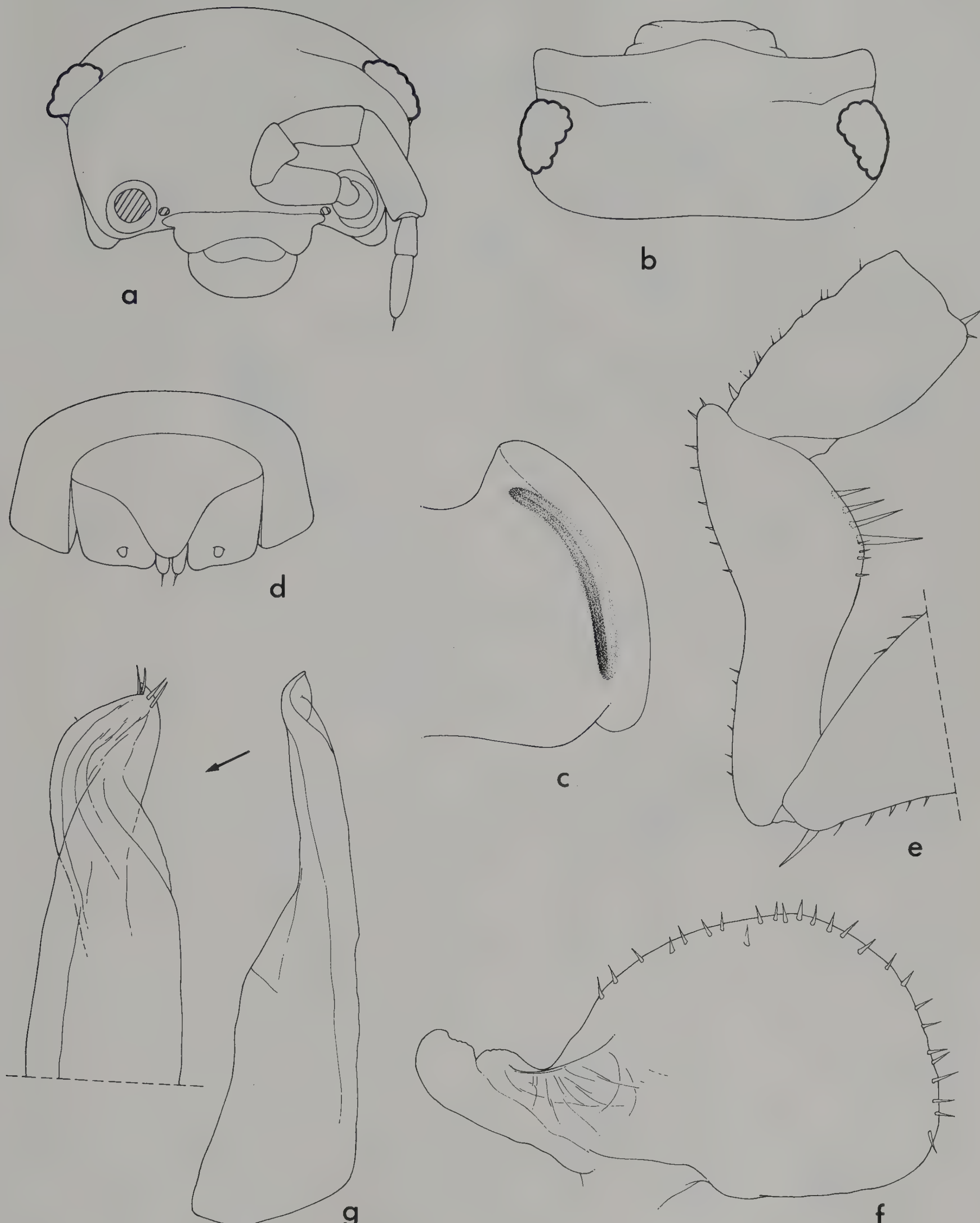


Fig. 15: *Koweitoniscus tamei* (Omer-Cooper, 1923), ♂: a, cephalon and left antenna, frontal view; b, cephalon, dorsal view; c, epimeron of pereon segment 1, dorsal view; d, pleon segment 5, telson and uropods; e, pereopod 7; f, pleopod 1 exopodite; g, pleopod 1 endopodite.

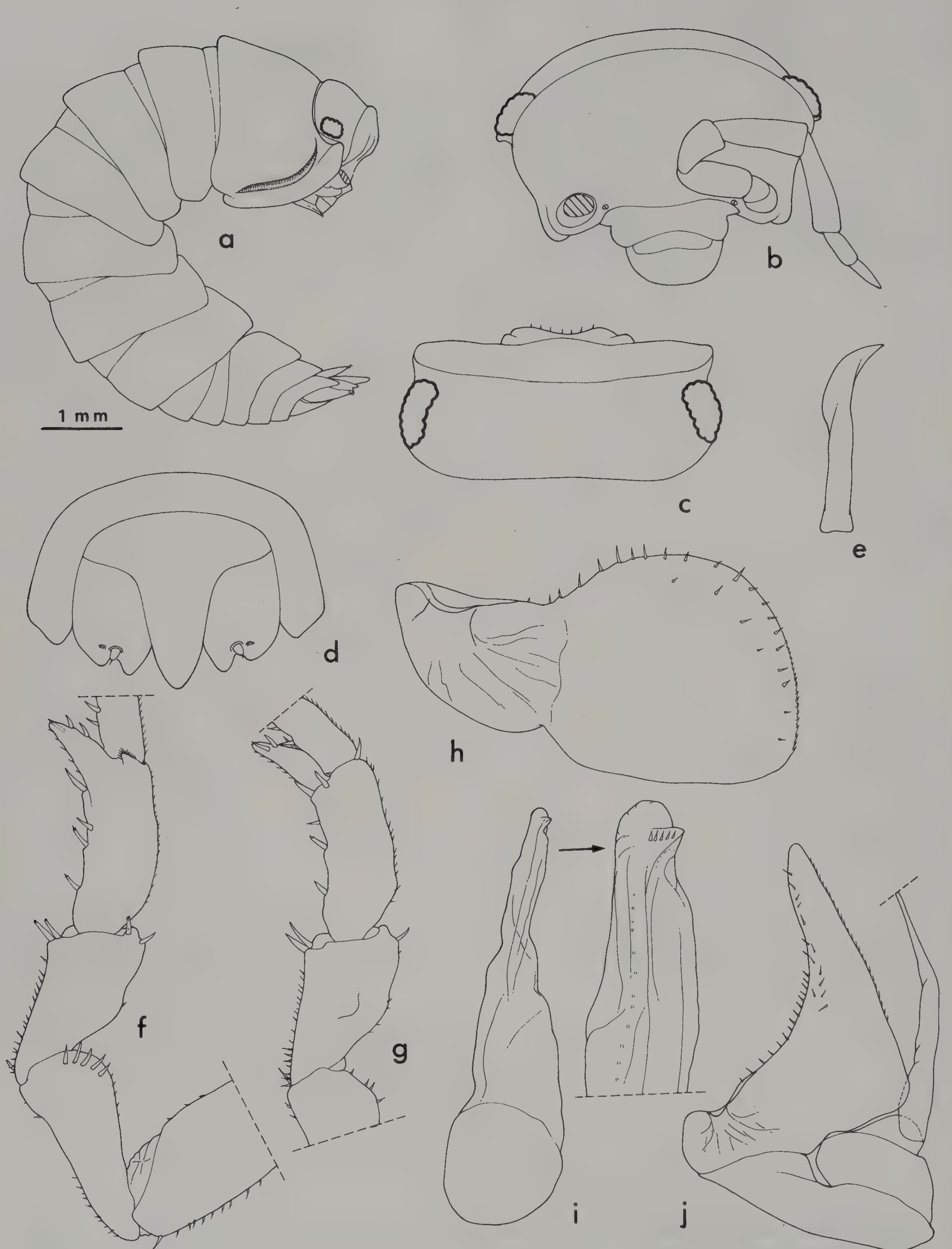


Fig. 16: *Koweitoniscus rostratus* n. sp., ♂: a, adult specimen, lateral view; b, cephalon and left antenna, frontal view; c, cephalon, dorsal view; d, pleon segment 5, telson and uropods; e, spine of sternal margin of pereopods 1–3 carpus; f, pereopod 7, caudal surface; g, pereopod 7, rostral surface; h, pleopod 1 exopodite; i, pleopod 1 endopodite; j, pleopod 2.

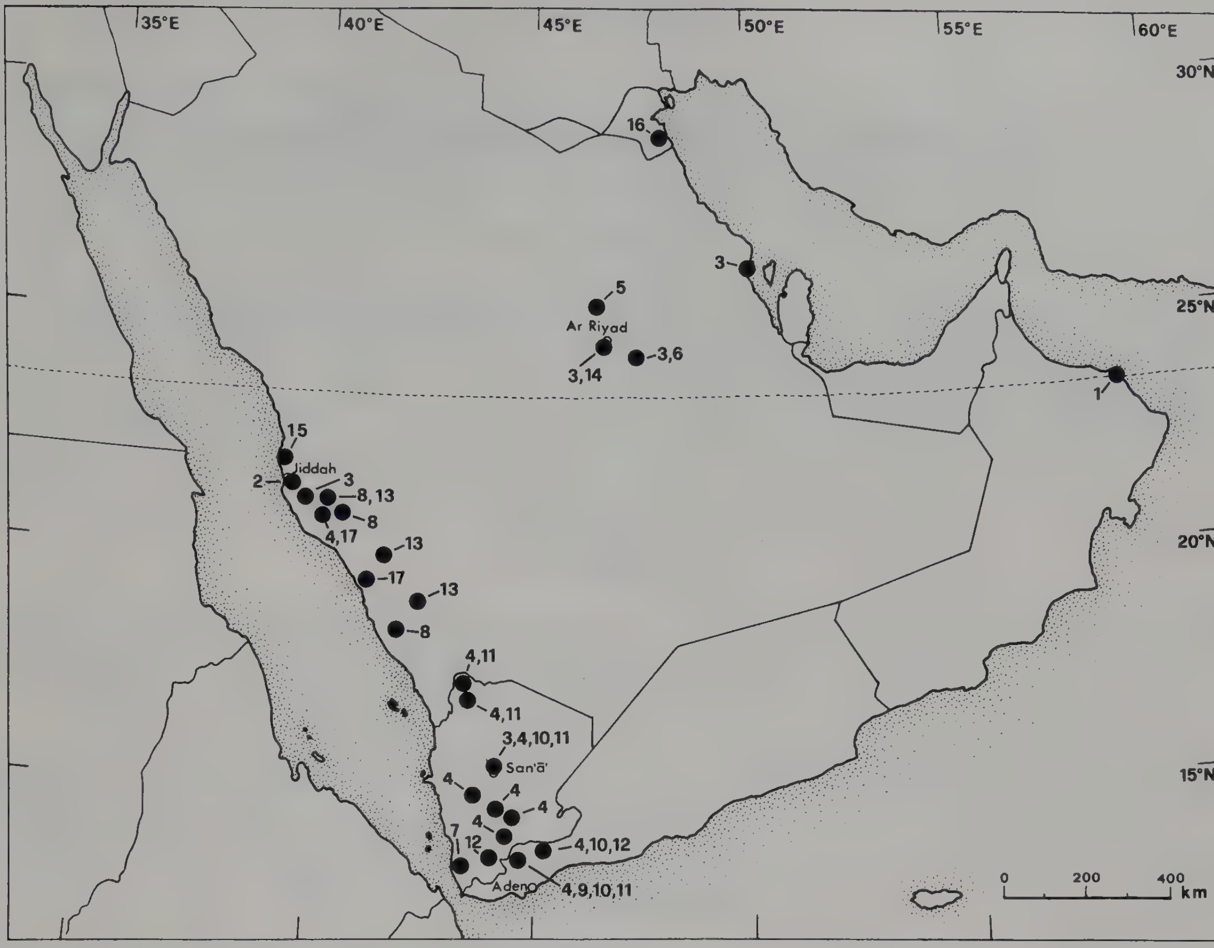


Fig. 17: Distribution of the terrestrial Isopoda species in the Arabian Peninsula: 1, *Tylos maindroni;* 2, *Protracheoniscus inexpectatus;* 3, *Porcellionides pruinosus;* 4, *Porcellio yemenensis;* 5, *P. assimilis;* 6, *P. evansi;* 7, *Periscyphis vittatus;* 8, *P. erythraeus;* 9, *P. bicoloratus;* 10, *P. besi;* 11, *P. arabicus;* 12, *P. barnardi;* 13, *P. buettikeri;* 14, *Periscyphis* sp.; 15, *Somalodillo paeninsulae;* 16, *Koweitoniscus tamei;* 17, *K. rostratus.*

# Isoptera of Saudi Arabia (Part 4)

**O. B. Chhotani, G. Bose**

Abstract: From a loan of termites of Saudi Arabia received from the Natural History Museum, Basel (Switzerland), two known but newly recorded species and eight re-recorded ones are reported in this paper.

Keywords: Isoptera, Saudi Arabia, taxonomy.

متساويات الاجنحة في المملكة العربية السعودية (الجزء الرابع)

ا. ب . شهوتاني و ج . بوزة

خلاصة : تم تسجيل نوعين من النمل الأبيض لاول مرة في المملكة العربية السعودية بالاضافة الى اعادة تسجيل ثمانية أنواع أخرى سجلت سابقا . حيث تمثل هذه المجموعة عينات أرسلت من متحف التاريخ الطبيعي في باسل (سويسرا) .

## INTRODUCTION

This contribution, dealing with the study of some further material collected by Prof. W. Büttiker in Saudi Arabia, received by courtesy of the Naturhistorisches Museum, Basel (Switzerland), is the fourth in the series of papers published by the present authors on the taxonomy and distribution of the termites of Arabia. The first two (1979 and 1982) dealt with the taxonomy of Isoptera from Saudi Arabia and the third (1983), with the distribution and affinities of Isoptera of the Arabian Peninsula with termites from Indian Desert and neighbouring countries. In this paper ten species are reported, of which eight already known are recorded from some further localities and two are new records from Saudi Arabia. The detailed distribution of the already known species is mentioned in earlier contributions and as such it is not repeated here.

Abbreviations: coll., collected by; Im, Imago; S, soldier; W, worker.

## DESCRIPTIONS

### Fam. **Kalotermitidae**

**1. *Epicalotermes aethiopicus*** Silvestri, 1918

*Epicalotermes aethiopicus* Silvestri, 1918, Boll. Lab. Zool. gen. agr. Portici, *12:* 348, 349–350.

Material and present records: One Im, Wadi Dhiyan, W. Büttiker, 13.,14.IX.1983.

## Fam. **Hodotermitidae**

2. ***Anacanthotermes ochraceous*** (Burmeister, 1839)

*Termes ochraceous* Burmeister, 1839, Handbuch der Entomologie, *2:* 765.

Material and present records: Im, S and W. Jeddah, W. Büttiker, 21.II.1978 (2 vials); Kushm Dibi, W. Büttiker, 20.IV.1978 (3 vials), 19.V.1978 (1 vial) and 10.X.1981 (1 vial).

3. ***Anacanthotermes saudiensis*** Chhotani & Bose, 1982

*Anacanthotermes saudiensis* Chhotani & Bose, 1982, Fauna of Saudi Arabia *4:* 74–77.

Material and present records: Five vials with Im and W, all W. Büttiker coll., as follows: Jebel Banban, 16.III.1978; Quwayiyah, 2.,3.III.1978, Wadi Khumrah, 9.,10.II.1978. Also 3 vials as follows: Wadi Khumrah, 660m, 17 km before Khaybar, KAU-NHMB Exp. N. Hedjaz 1979, 22.IV.1979; Hofuf, 4.IV.1979, W. Büttiker, destroying wood in house; and Wadi Bani Malek, 8.II.1983.

## Fam. **Rhinotermitidae**

4. ***Psammotermes hybostoma*** Desneux, 1902

*Psammotermes hybostoma* Desneux, 1902, Annls Soc. ent. Belg., *46:* 437–438.

Material and present records: Im, S and W, all coll. W. Büttiker, as follows: Jeddah, 7.V.1978; Al Khubra, 30.V.1978, 8.II.1979 and 10.V.1979; Riyadh, 20.I.1979, attacking timber in house and 20.III.1979; Hofuf, 8.III.1978; Al Khobar, III.1979, attacking wood in house; Wadi Juranah, 26.II.1982; Wadi Majarish, 7.I.1983, 8.I.1983 and 11.II.1983; Bahara, 12.X.1982; Addar, 28.I.1983 (2 vials) and 1.II.1983; Wadi Bani Malek, 8.II.1983; Wadi Hanaq (Camp 2), 19.,20.I.1984 (2 vials). Also Wadi Al Faraah near Yanbo, 19.IV.1979, KAU-NHMB N. Hedjaz Expedition.

5. ***Heterotermes wittmeri*** Chhotani & Bose, 1982

*Heterotermes wittmeri* Chhotani & Bose, 1982, Fauna of Saudi Arabia *4:* 78–81.

Material and present records: Im, S, W, coll. W. Büttiker, thus: Turaba, 30.IX.1978 (2 vials); Wadi Bani Malek, 8.II.1983, also one vial without data.

## Fam. **Termitidae**

6. ***Amitermes messinae*** Fuller, 1922

*Amitermes messinae* Fuller, 1922. S. Afr. J. nat. Hist., *3* (2) : 125.

Material and present records: Im, S and W, coll. W. Büttiker, thus: Jeddah, 13.XII.1982 and 15.XII.1982; Bahara, 12.X.1982.

Remarks: So far this species in the Arabian Peninsula was known only from S. Yemen, the present is first record from Saudi Arabia. From Africa it is recorded from S. Africa, Malawi, Tanzania, Kenya and Sudan.

7. ***Amitermes vilis*** (Hagen, 1858)

*Termes vilis* Hagen, 1858, Linn. Ent., *12:* 185.

Material and present records: S and W, Riyadh, 3.VI.1978, W. Büttiker.

Remarks: Badawi et al. (1984) while conducting population studies of some termites reported this species from Al Kharj.

8. ***Microcerotermes buettikeri*** Chhotani & Bose, 1979

*Microcerotermes buettikeri* Chhotani & Bose, 1979, Fauna of Saudi Arabia *1:* 77–80.

Material and present records: Im and W. Jeddah, V.1979 (W only), feeding on carpets in a house; Kashm Kafs, 20.II.1981, W. Büttiker.

9. ***Angulitermes truncatus*** Sjöstedt, 1926

*Angulitermes truncatus* Sjöstedt, 1926, Ent. Tidskr., *47:* 244–246.

Material and present records: S and W, Wadi Daykah, W. Büttiker, 12.XI.1982 (2 vials).

Remarks: So far known from Ghana, Nigeria, Uganda, Kenya and Tanzania in Africa. It is recorded from Saudi Arabia for the first time.

10. ***Microtermes subhyalinus*** Silvestri, 1915

*Microtermes subhyalinus* Silvestri, 1914–15, Boll. Lab. Zool. gen. agr. Portici, *9:* 21–23.

Material and present records: Im, S and W, Al Faraah, 1800 m, W. Büttiker, 15.X.1982.

Remarks: The imago in this collection is somewhat larger in size.

## ACKNOWLEDGEMENTS

We are grateful to Prof. Büttiker, Meteorology and Environmental Protection Administration, Jeddah (Saudi Arabia) and to Drs M. Brancucci and W. Wittmer, Naturhistorisches Museum, Basel (Switzerland) for giving us the opportunity to study the collections and to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for his encouragement.

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# Lygaeidae: Subfam. Lygaeinae of Saudi Arabia (Hemiptera: Heteroptera)

A. Hamid, B.L. Hamid

Abstract: 20 species of Lygaeinae are reported from Saudi Arabia. Two new species, *Lygaeus buettikeri* n. sp. and *Tropidothorax wittmeri* n. sp., and one new subspecies, *Tropidothorax sternalis saudiensis* n. ssp., are described. Known distribution of all species is indicated.

Keywords: distribution, Hemiptera, Heteroptera, Lygaeidae, Lygaeinae, taxonomy.

Lygaeidae المتفرعة من عائلة Lygaeinae في المملكة العربية السعودية (Hemiptera : Heteroptera)

أ. حميد وب . ل . حميد

خلاصة : سجل وجود ٢٠ نوع من Lygaeinae في المملكة العربية السعودية . وقد تم وصف نوعين جديدين همـــا : Lygaeus buettikeri n. sp. و Tropidothorax wittmeri n. sp. ونـــوع فـرعي جديد Tropidothorax sternalis saudiensis n. ssp. وجرت الاشارة الى التوزيع المعروف لكل الانواع .

## INTRODUCTION

The Lygaeidae fauna of the Arabian peninsula has so far not received the attention that it deserves. A number of species have been recorded from this area (SLATER 1964a, LINNAVUORI & ALAMY 1982) but no comprehensive study exists. The present study is based mainly on the material collected by Prof. W. Büttiker, Jeddah, Prof. A.S. Talhouk, Riyadh, and Dr. W. Wittmer, Basel, but species previously reported from the area and not represented in this material are also included. Mentioned in here also are those taxa that we would expect to be found in this region, because they are reported from adjacent areas. Only selected synonymy has been given. For detailed information on synonymy, distribution, host plant data, etc., reference should be made to SLATER's (1964a) catalogue.

The family Lygaeidae is one of the three largest families of Heteroptera as far as the number of species is concerned. It is a large, worldwide family of predominantly brown or black bugs often marked with white areas. Some members display bright red and white aposomatic coloration and others are cryptically colored.

The family is typically pentatomomorphic (LESTON et al. 1954), has two veins (R and M) in the hind wing distad of the discal cell, symmetrical male genitalia (BONHAG & WICK 1953), and non-operculate eggs (COBBEN 1968). Its members have four to five longitudinal veins in the membrane of the forewing. Their antennae are inserted below a line drawn through the center of eye to apex of head (CHINA & MILLER 1959). They possess ocelli, four-segmented antennae, three-segmented tarsi, a four-segmented labi-

um and a well developed gular area. Their phallus consists of three distinct regions (phallotheca, conjunctiva, and vesica) (Ashlock 1957).

Most of the Lygaeidae feed on seeds, although one subfamily (Geocorinae) are known to be entomophagous. *Clerada* (Rhyparochrominae) and some allied genera are bloodsuckers, being ectoparasitic on opossums and other mammals (Lent 1939, Southwood & Leston 1959, Slater 1964b).

The present paper deals with only the subfamily Lygaeinae in detail. However, a key to the subfamilies of Lygaeinae of Saudi Arabia is also included. In subsequent papers we intend to deal with the remaining subfamilies mentioned here.

**Key to Saudi Arabian subfamilies of Lygaeidae**

Modified from Slater (1964b) and China & Miller (1959)

1. Abdominal suture between sternites four and five curving forward laterally and giving the appearance of not extending to lateral margins (fig. 2) **Rhyparochrominae**
– All abdominal sutures complete and extending to lateral margins of abdomen, not curving forward . . . . . . . . . 2
2. Abdominal spiracles on segments two through seven all located dorsally . . . . . . . . . 3
– At least one pair of spiracles on abdominal segments two through seven located ventrally 5
3. Clavus punctate at least in part; hind margin of pronotum not depressed laterad of base of scutellum **Ischnorhynchinae**
(Probably in Saudi Arabia, although not yet actually reported)
– Clavus impunctate; hind margin of pronotum depressed between scutellum and lateral angles . . . . . . . . . 4
4. Apical corial margin straight; hind wing possessing a subcosta and lacking intervannals **Lygaeinae**
– Apical corial margin sinuate on mesal half (fig. 3); hindwing lacking a subcosta and possessing intervannals **Orsillinae**
5. Abdominal spiracle on segment seven ventral, others dorsal . . . . . . . . . 6
– Abdominal spiracles on at least segments six and seven ventral . . . . . . . . . 7
6. Hemelytra coarsely punctate **Cyminae**
– Hemelytra impunctate or at most with weak scattered punctures; narrow parallel-sided bugs **Blissinae**
7. Abdominal spiracles at least on segments three and four located dorsally; eyes usually protruding or reniform . . . . . . . . . 8
– Abdominal spiracles on segments three to seven all located ventrally . . . . . . . . . 9
8. Abdominal spiracles on segment five located dorsally, those on segment two located ventrally **Henestarinae**
– Abdominal spiracles on segment five located ventrally, those on segment two placed dorsally **Geocorinae**
9. Abdominal spiracles on segment two located dorsally; clypeus may or may not be expanded . . . . . . . . . 10
– Abdominal spiracles on segment two located ventrally; clypeus not expanded . . . . . . . 11
10. Lateral margins of pronotum laminate; lateral margins of corium not widely laminate; tylus (clypeus) not expanded at apex **Artheneinae**
(Probably in Saudi Arabia, although not yet actually reported)

– Lateral margins of pronotum not laminate; lateral margins of corium widely laminate; tylus (clypeus) expanded at apex, sometimes bulbous **Oxycareninae**

11. Cross vein present in membrane of front wing, creating a closed basal cell; forefemora usually at most weakly spinose and incrassate; hamus of hind wing arising distad of point on discal cell where cubitus diverges as a free vein **Heterogastrinae**

– Cross vein and resultant closed basal cell absent in membrane of forewing; forefemora strongly incrassate and heavily spined; hamus arising in discal cell basad of divergence of cubitus as a free vein **Pachygronthinae**

## Subfam. **Lygaeinae** Schilling, 1829

Lygaeides Schilling, 1829. – Beitr. Ent. Schles. Fn. *1:* 35, 37.
Lygaeida. – Stal 1862; Ofv. Vet. Akad. Forh. *19:* 210.
Lygaeina. – Stal 1872; Ofv. Vet. Akad. Forh. *29:* 37, 40–44.
Lygaeini. – Usinger & Ashlock 1959; Proc. Haw. Ent. Soc. *17:* 99.
Lygaeinae. – Slater 1964; Cat. Lyg. World *1:* 8.

The subfamily Lygaeinae credited to Schilling (ICZN 1964, Hamid & Meher 1973) includes most of the larger species of Lygaeidae. Most members of this subfamily are brightly colored, having a combination of black, red, orange and white shades, often arranged in beautiful contrast. Many of them feed upon the mature seeds of plants, but sapsucking is widespread. Frequently they occur in ground litter below the host plants. Many species are encountered on the plants, feeding on the seeds or other host tissues. Many species are associated with “milkweeds” and members of the plant families Asclepiadaceae, Compositae, Tiliaceae, Convolvulaceae, and Chenopodiaceae (Slater & Sperry 1973, Hamid & Ahmed 1972, Hamid & Meher 1973), among others.

The subfamily is characterized by the presence of a pair of ocelli, all abdominal spiracles are located dorsally, abdominal sutures are straight and attain lateral margins, apical corial margin is straight, hemelytra are generally impunctate, membrane of forewing has a distinct basal cell, hindwing has a subcosta basally, intervannals are absent but hamus is present, phallus has phallothecal processes, conjunctiva is without sclerites and secondary gonoporal process is long and coiled (Ashlock 1957). The model number of chromosomes for the subfamily is 14 (12+XY) although some species vary from this number (Ueshima & Ashlock 1980).

The present study is based on the lygaeine material included in nine genera and thirteen species collected mostly by Prof. W. Büttiker, Prof. A. S. Talhouk and Dr. W. Wittmer. Included in this report are two additional genera and three additional species that have been reported from this area but are not represented in the material at hand from the Arabian peninsula. Included in the checklist is also a species of *Horvathiolus* that our colleague Dr. R. Linnavuori is describing. This brings the total number to 20 species included in 12 genera.

The distribution of these species in Saudi Arabia is shown in fig. 1. We have also included on the map the known distribution of the studied species in North and South Yemen. This we believe will help to better understand the zoogeography of the Saudi Arabian Lygaeinae. For further information about the topography and vegetation of actual sampling sites, reference should be made to Büttiker (1980a&b, 1981) and Büttiker & Wittmer (1979). The studied material is located in the Naturhistorisches Museum, Entomologie, Basel, Switzerland and A. Hamid collection unless otherwise indicated.

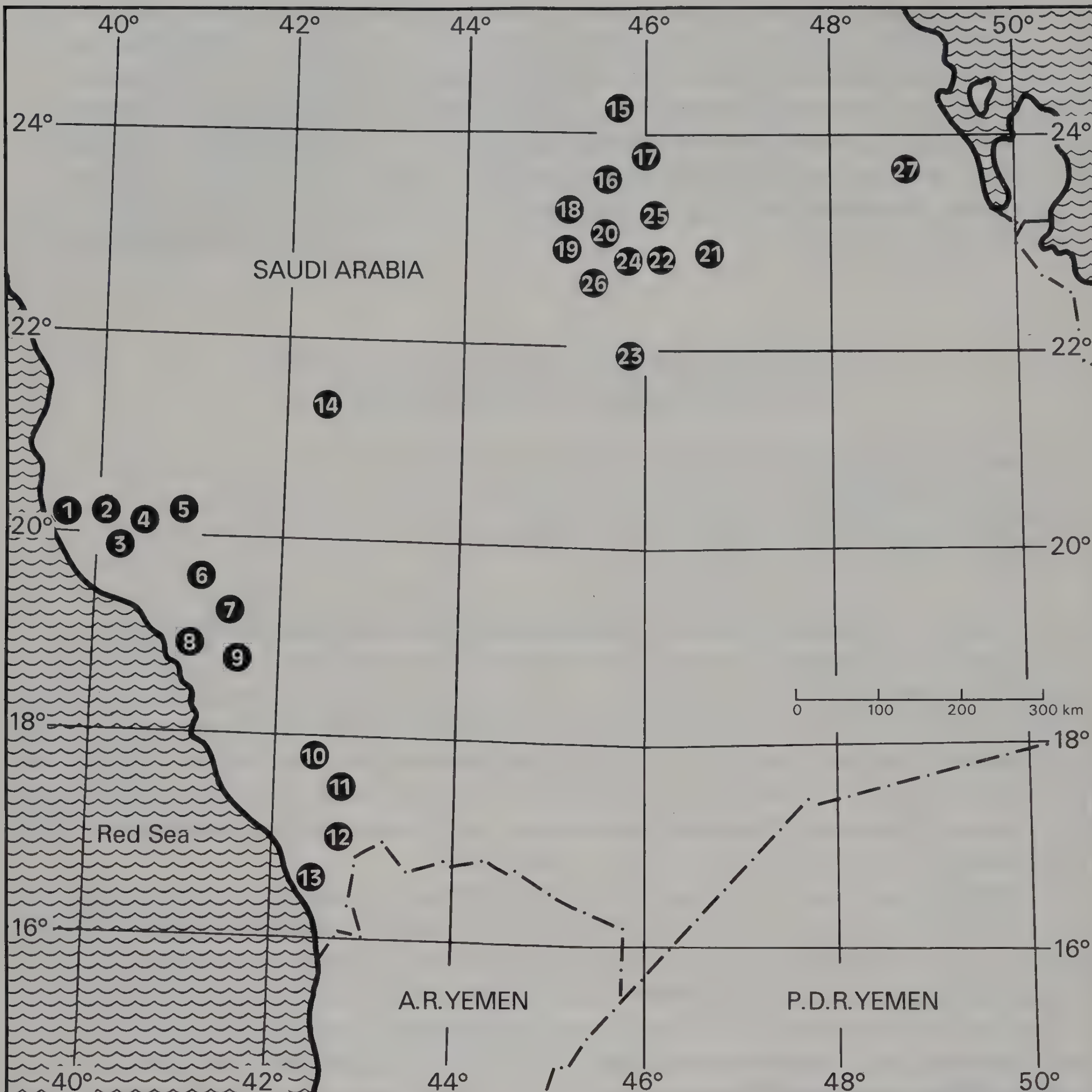



Fig. 1: Map of Saudi Arabia showing the collecting localities. Numbers in parentheses indicate the checklist number for species collected at each locality: 1. Jeddah (15); 2. Jeddah/Taif (13); 3. Wadi Majarish (13); 4. Taif (13); 5. Suwaydarah (13); 6. W. Shuqub/Turabah (20); 7. Biljurshi (7); 8. Wadi Uqdah (19); 9. Al Alayyah (7); 10. Khamis Mushayt (18); 11. Qaraah (16); 12. Fifa (4); 13. Gizan (15); 14. Afif (13); 15. Al Rass (13); 16. Irq Ratimah (13); 17. Khasm Khafs (13); 18. W. Hanifa (11); 19. Khushm Dibi (13); 20. W. Awsat (13); 21. Al Kharj (15); 22. Hair (13); 23. Hieth (5); 24. Riyadh and environs (3, 5, 10, 11, 12, 13, 15); 25. Malhim (13); 26. W. Shaib Luha (13); 27. Hofuf (3).

## Checklist of Saudi Arabian Lygaeinae

1. *Aspilocoryphus fasciativentris* (Stal)
2. *Caenocoris nerii* (Germar) (suspected to occur in Arabia)
3. *Cosmopleurus fulvipes* (Dallas)
4. *Graptostethus servus* (Fabricius)
5. *Hormopleurus nysioides* Horvath
6. *Horvathiolus* sp. (Dr. R. Linnavuori is describing this species [personal communication])
7. *Lygaeus buettikeri* n. sp.
8. *L. creticus* Lucas
9. *L. equestris* (Linnaeus) (suspected to occur in Arabia)
10. *Melanotelus villosulus* (Stal)
11. *Paranysius fallaciosus* (Puton)
12. *Spilostethus furculus* (Herrich-Schaefer) (new record)
13. *S. longulus* (Dallas)
14. *S. pandurus pandurus* (Scopoli)
15. *S. p. militaris* (Fabricius) (new record)
16. *S. rivularis epimetheus* Linnavuori
17. *S. saxatilis* (Scopoli) (suspected to occur in Arabia)
18. *Stenaptula angusticollis* (Lindberg)
19. *Tropidothorax sternalis saudiensis* n. ssp.
20. *T. wittmeri* n. sp.

## Key to the genera and species of Lygaeinae of Saudi Arabia

| | | |
|---|---|---|
| 1. | Metathoracic scent gland orifice obsolete, represented laterally only by a simple groove, never with a raised ear-like lobe (fig. 4) . . . . . . . . . . . . . . . . . . . . | 2 |
| – | Metathoracic scent gland orifice well developed, represented laterally by a raised lobate process (figs 5, 6, 7) . . . . . . . . . . . . . . . . . . . . | 8 |
| 2. | Males with femora conspicuously spinose below (fig. 8) Genus ***Spilostethus*** | 3 |
| – | Both sexes with femora mutic ***Stenaptula angusticollis*** | |
| 3. | Corium with a distinct transverse black fascia extending from lateral margin at least mesad to cubital vein; lateral longitudinal red or pale stripe if present interrupted by broad black fascia . . . . . . . . . . . . . . . . . . . . | 4 |
| – | Corium lacking a transverse black fascia; lateral red or pale stripe present and entire, usually widening posteriorly ***Spilostethus rivularis epimetheus*** | |
| 4. | Membrane transparent or milky white, darkened only at base and along basal portion of veins; if transparent, without white spots ***Spilostethus pandurus pandurus*** | |
| – | Membrane uniformly black, dark brown or brown, with white spots . . . . . . . . . . . . . | 5 |
| 5. | Wing membrane uniformly black; transverse black fascia on corium broadly expanded laterad; longitudinal black stripe on pronotum usually continuous from anterior to posterior margin ***Spilostethus furculus*** | |
| – | Wing membrane black but with one or more white spots; transverse black corial fascia of nearly uniform width throughout; longitudinal black stripes on pronotum may or may not be interrupted in area of calli . . . . . . . . . . . . . . . . . . . . | 6 |
| 6. | Longitudinal black fascia on pronotum almost always interrupted in area of calli; trans- | |

verse fascia on corium extending throughout corial width, never lacking mesally; apical ⅓ to ½ of scutellum red ***Spilostethus longulus***

– Longitudinal black fascia on pronotum not interrupted in area of calli, running from anterior to posterior margin; transverse fascia on corium may or may not extend throughout corial width (fig. 11); scutellum unicolorous, extreme apex may be lighter in color but median carina always black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

7. Clavus with distinct oval black spot near apex of scutellum; large species, 14.5 mm long ***Spilostethus pandurus militaris***

– Posterior ⅓ of clavus uniformly black (fig. 11); small species, 9.5 mm long ***Spilostethus saxatilis***

8. Scutellum tumid and swollen, sometimes with a weak carina but never having adjacent areas deeply excavated Genus ***Tropidothorax*** 9

– Scutellum never tumid and swollen, always with a distinct median carina, adjacent areas flat or deeply excavated . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10

9. Corium unicolorous orange, membrane black with a median oval white area ***Tropidothorax wittmeri***

– Corium orange with a medium black area, membrane black, margin and basal angle white but no median white area ***Tropidothorax sternalis saudiensis***

10. Eyes set well away from anterolateral pronotal angles (fig. 9); area behind eyes tumid ***Caenocoris nerii***

– Eyes contiguous or nearly contiguous with anterolateral pronotal angles . . . . . . . . . . 11

11. Head black, if marked with paler coloration then at least with base of head black . . . . 12

– Head usually light in color, if black at least with a maculate spot at base of vertex red or yellow . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 13

12. Hairs on pronotum longer than width of second antennal segment; wing membrane without a median white spot; pronotum with two black spots in posterior half ***Melanotelus villosulus***

– Hairs on pronotum shorter than width of second antennal segment; wing membrane with a median white spot (fig. 12); pronotum with black longitudinal fascia extending most of pronotal length (fig. 10) ***Aspilocoryphus fasciativentris***

13. Head light in color; pronotum distinctly punctate as compared to hemelytra; membrane of hemelytra hyaline with brown veins ***Paranysius fallaciosus***

– Head red and black or dark brown with a maculate pale spot at base; pronotum impunctate; membrane of hemelytra dark brown, usually with lighter spots or areas, veins not differently colored . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 14

14. Head, except basal maculate spot, black or dark brown; general body color brown without any red areas ***Hormopleurus nysioides***

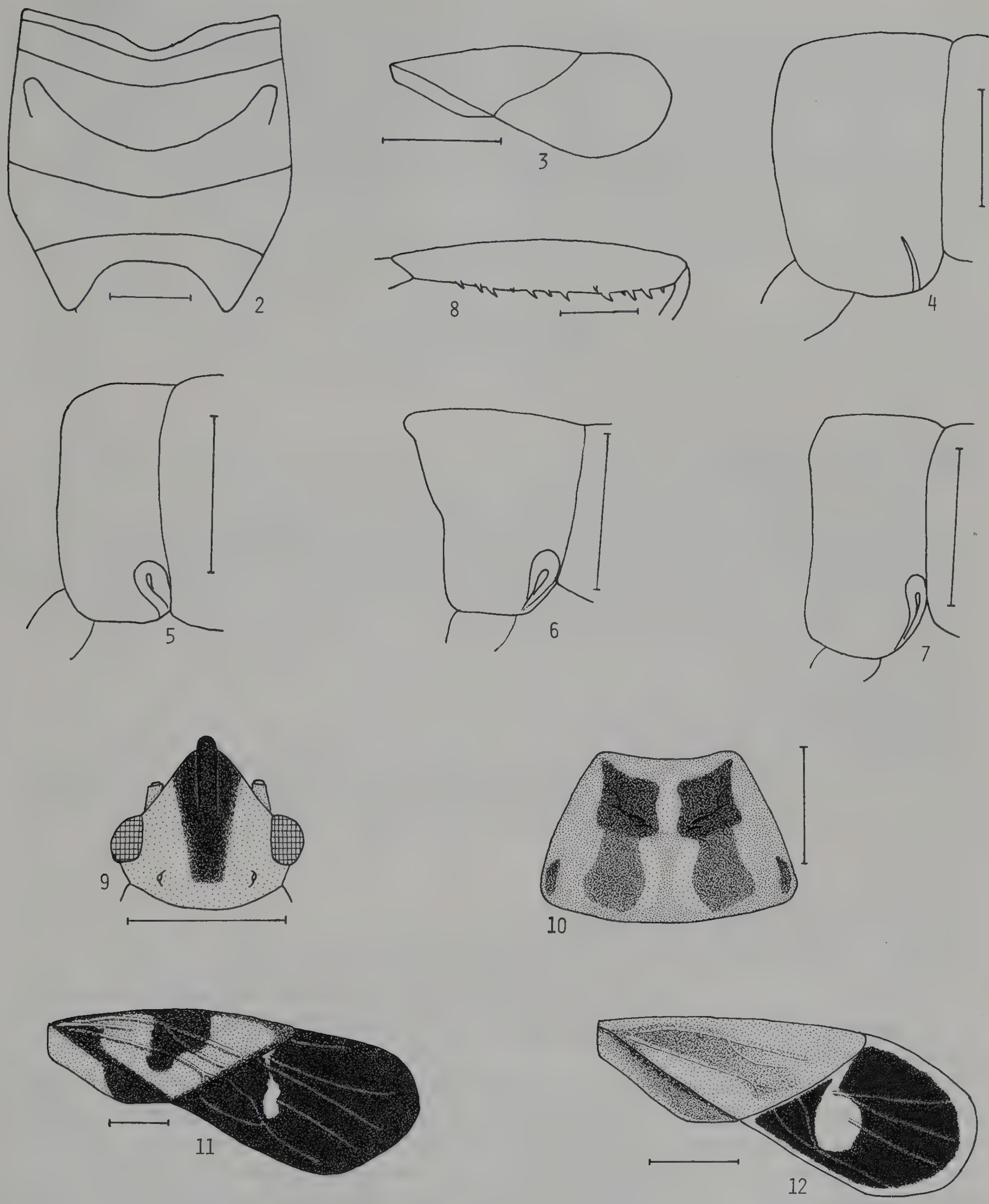
– Head red and black, if all black or as above, then pronotum and/or hemelytra with red areas; general body color red and black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15

15. Apical ⅔ of femora, tibia and first tarsal segments orange-red; pronotum black ***Cosmopleurus fulvipes***

– Legs black; pronotum red or orange with or without black markings . . . . . . . . . . . . . 16

16. Posterior margin of metapleuron angulate, extending cephaloventrad from dorsal angle (fig. 6) ***Graptostethus servus***

– Posterior margin of metapleuron either nearly straight dorsoventrally or conspicuously rounded and convex (fig. 7) Genus ***Lygaeus*** 17



Figs 2–12: 2, *Dieuches syriacus* abdomen, ventral view; 3, *Nysius ericae* forewing; 4, *Spilostethus pandurus militaris* metapleuron; 5, *Tropidothorax wittmeri* metapleuron; 6, *Graptostethus servus* metapleuron; 7, *Lygaeus buettikeri* metapleuron; 8, *Spilostethus longulus* hind femur; 9, *Caenocoris nerii* head, dorsal view; 10, *Aspilocoryphus fasciativentris* pronotum; 11, *Spilostethus saxatilis* forewing; 12, *Aspilocoryphus fasciativentris* forewing. (Scale bar 1 mm).

17. Thoracic pleura red and yellow with some black ***Lygaeus buettikeri***
– Thoracic pleura uniformly black .................................................. 18
18. Head black; corium red except a median circular black spot; wing membrane fuscous without a median circular white area ***Lygaeus creticus***
– Head red and black; corium with broad median transverse black band; wing membrane with a median circular area, a triangular basal area and margins white ***Lygaeus equestris***

## DESCRIPTIONS

***Aspilocoryphus fasciativentris*** (Stal, 1858)

*Lygaeus fasciativentris* Stal, 1858. – Ofv. Vet. Akad. Forh. *15:* 316, 317.
*Aspilocoryphus fasciativentris.* – Stal 1874; Enum. Hem. *4:* 117.

The species was originally described from South Africa (Stal 1858). Gerstaecker (1873) reported it from Arabia. We do not have this species in the present Saudi Arabian material.

Known distribution: Central, East and South Africa, Arabia, Cape Verde, Ethiopia, Mozambique, Nigeria, Pakistan, Tanganyika, Zaire.

***Caenocoris nerii*** (Germar, 1847)

*Lygaeus nerii* Germar, 1847. – Faun. Eur. *24:* 17.
*Caenocoris nerii.* – Fieber 1861; Eur. Hem.: 166.

This species was originally described by Germar (1847), probably from Europe. Since then it has been reported from a large number of localities in Europe, Africa, the Middle East, Iran and Pakistan. Although it has not been taken in Saudi Arabia we would suspect that it occurs there.

***Cosmopleurus fulvipes*** (Dallas, 1852)

*Lygaeus fulvipes* Dallas, 1852. – List Hem. B.M. *2:* 536.
*Lygaeus (Cosmopleurus) fulvipes.* – Stal 1872; Ofv. Vet. Akad. Forh. *29:* 41.

Material: 1 ♂, Saudi Arabia, Riyadh, 30.VIII.80; 1 ♀, Saudi Arabia, Hofuf, 28.VIII.80.

This species, originally described from Egypt (Dallas 1852), has since been reported from a number of other countries including Arabia (China 1934, Stichel 1957). We have two specimens in our present sample as detailed above.

The species can be easily identified because of its orangish red legs and antennae. The head is black with a basal pale maculate spot on the vertex. The pronotum and scutellum are the same color as the head, except for the apex of the scutellum, which is orange. The clavus is brown with a darker spot near the apex of the scutellum and the corium is orange with one median black spot. The wing membrane is mostly brown with apical margin, basal angle and an oval median area lighter in color. Venter is mostly dark brown.

Known distribution: North and West Africa, Arabia, Iran, Pakistan, Palestine, Syria.

***Graptostethus servus*** (Fabricius, 1787)

*Cimex servus* Fabricius, 1787. – Mant. Ins. *2:* 300.
*Lygaeus (Graptostethus) servus.* – Stal 1868; Hemip. Fabr. *1:* 74–75.

Material: 1 ♀, Saudi Arabia, Fifa, 18.XI.1981, W. Büttiker.

This species was described by FABRICIUS (1787) from China. Subsequently it has been reported from many other countries including Arabia (REUTER 1890, WU 1935, STICHEL 1957). We have one specimen in our present study material.

The species can be easily indentified by its red and black head with a pale basal maculate spot on the vertex. The pronotum has a transverse black band in the callar region and an almost complete transverse black band at the posterior margin. Between the two bands there is a pair of black circular spots. The scutellum is dark brown, except for the lateral margins near the apex which are orange. Margins of the hemelytra are orange, the median areas are brown. The wing membrane is mostly dark brown, except for the outer margin which is whitish.

Known distribution: Africa (widely distributed), Arabia, Australia, Burma, China, Europe, India, Indonesia, Japan, Malaysia, Mediterranean, Pakistan, South Pacific Islands, Sri Lanka, Syria, Tibet, Turkey.

***Hormopleurus nysioides*** Horvath, 1884

*Hormopleurus nysioides* Horvath, 1884. – Term. Fuzetek *8:* 9–10.

Material: 1 ♂, Saudi Arabia, Hieth, 40 km S Riyadh, 13.V.77, W. Büttiker.

This is the only species in the genus *Hormopleurus.* It was originally described from Syria by HORVATH (1884). Subsequently it was reported from Palestine (BODENHEIMER 1937) and from Sudan on *Aerva gavanica* (LINNAVUORI 1978). Recently LINNAVUORI & ALAMY (1982) reported it from Saudi Arabia. We have the same specimen that Linnavuori studied.

The species can be easily identified because of its small size (maximum length 3.5 mm), uniformly dark brown head with a maculate pale spot on vertex, dark brown callar region, dark brown basal ½ of scutellum, and uniformly light brown corium. The wing membrane is dark brown centrally and transparent apically. A more detailed description of this species, including the structures of genitalia, is being undertaken elsewhere (HAMID & HAMID in prep.).

Known distribution: Palestine, Saudi Arabia, Sudan, Syria.

***Lygaeus buettikeri*** n. sp.

Material: Holotype, ♀, Saudi Arabia, Al Alayyah, 19°39'N 41°54'E, 1950 m, 6.–10.X.79, W. Büttiker, NHMB. Paratype, 1 ♀, Saudi Arabia, 81 km S Biljurshi, 19°51'N 41°33'E, 2000 m, VIII.1979, G. Vogel, A. Hamid collection.

Head black except for an inverted V-shaped area extending from posterior margin to sides of tylus red, bucculae yellow. Pronotum black except for five areas, two around calli, two at posterior lateral angles and one along posterior half of median carina, red; a narrow area lateral to red median carina and posterior margin yellow. Scutellum black except for median carina red and areas adjacent to median carina near apex yellow. Basal ⅓ of clavus red, a median oval spot black, rest of clavus dark brown; claval margins along commissure and posterior ⅔ of claval suture yellow. Corium red except for inner margin and basal ⅔ of outer margin dark brown to black, black area on outer margin slightly expanded near base, a median circular spot near apex of clavus black; apical margin yellow. Wing membrane fuscous, basal triangular area darker. Antennae, labium and legs dark brown. Anterior prosternal margin, posterior margins of all thoracic sterna, area around coxae and metathoracic scent gland auricle pale yellow; discs of thoracic sterna red, surrounded by black areas; posterior dorsal angle of each pleuron with a black oval or circular spot. Abdominal venter red with black streaks along four or five segmental margins alternated by elongate black spots; genital segments black.

Head moderately convex, declivent; pronotal discs more or less flat, red areas around calli slightly elevated; scutellum with a T-shaped carina; hemelytra exceeding apex of abdomen. Total length body 8.19 mm, maximum width 2.94 mm, length head 1.05 mm, width head 1.47 mm, length pronotum 1.58 mm, width pronotum 2.52 mm, length scutellum 1.16 mm, width scutellum 1.47 mm, length corium 4.31 mm, length membrane 3.78 mm, length antennal segments I 0.53 mm, II 1.16 mm, III 1.05 mm, IV 1.26 mm.

This species is named in honour of the collector of the holotype, Dr. W. Büttiker, who has contributed immensely to the knowledge of the Saudi Arabian fauna.

The species resembles *Lygaeus dives* (Distant, 1918) and *Lygaeus dives ocellaris* (Linnavuori, 1978) but differs from both in coloration as described above. The antenna is 1.6 times as long as the width of the pronotum. In the nominate form it is 1.7 times the length and in *L. d. ocellaris* it is 1.8 times the length (Linnavuori 1978). The ratios between the antennal segments of *L. buettikeri* are also different from the other two taxa.

***Lygaeus creticus*** Lucas, 1854

*Lygaeus creticus* Lucas, 1854. – Rev. Mag. Zool. *2* (6): 280–281.

This species was described originally from Crete (Lucas 1854). Subsequently it has been reported from many other countries (Slater 1964a, Hamid & Meher 1976) including Arabia (China & Miller 1950, Stichel 1959). Our study material does not include specimens of this species.

This species can be distinguished from the related taxa by its black head except for a basal median pale macula; a black pronotum except for the shoulders and a median red area; and red clavus and corium, both with one circular black spot.

Known distribution: Afghanistan, Arabia, Corfu, Crete, Cyprus, Greece, Iran, Italy, Libya, Pakistan, Palestine, Sardinia, Sicily, Syria, Turkey, Yugoslavia.

***Lygaeus equestris*** (Linnaeus, 1758)

*Cimex equestris* Linnaeus, 1758. – Sys. Nat. Edit. *10:* 447.

*Lygaeus equestris.* – Fabricius 1794; Ent. Syst. *4:* 147.

This is a very widely distributed species. It occurs in Europe, North Africa, the Middle East, Pakistan, India, Siberia and Japan. It has not actually been reported from Saudi Arabia but is very likely to occur there.

***Melanotelus villosulus*** (Stal, 1855)

*Lygaeus villosulus* Stal, 1855. – Ofv. Vet. Akad. Forh. *12:* 32.

*Melanotelus villosulus.* – Reuter 1885; Rev. d'Ent. *4:* 202.

*Lygaeosoma villosula.* – Slater 1964; Cat. Lyg. World *1:* 72.

*Melanotelus villosulus.* – Slater & Sperry 1973; Ann. Transv. Mus. *28:* 157–159.

Material: 1 ♂, Saudi Arabia, Riyadh 16.IV.78, W. Büttiker.

This species was initially described from South Africa (Stal 1855). Subsequently it was reported from East, West and North Africa, the Middle East and Pakistan. It has also been reported from Arabia by several workers (Slater 1964a). We have one specimen from Saudi Arabia in our present material.

This species can be easily distinguished from the related taxa by its hirsute appearance and uniformly dark brown head, antennae and legs. The pronotum has two triangular brown spots at the shoulders. The scutellum has a distinct T-shaped reddish carina; other areas of the scutellum are brown. Clavus and corium are uniformly red; the wing membrane is mostly dark brown but the entire basal margin has an irregular white area and the apex is also white. The thoracic pleura and abdominal venter are mostly red. The pro- and metapleura each have a dark brown spot and genital segments are dark brown.

***Paranysius fallaciosus*** (Puton, 1895)

*Arocatus fallaciosus* Puton, 1895. – Rev. d'Ent. *14:* 85.

*Paranysius fallaciosus fallaciosus.* – China 1935; Ann. Mag. Nat. Hist. (10) *16:* 468.

Material: 4 ♂♂ and 8 ♀♀, Saudi Arabia, Riyadh, 26.I.80, A.S. Talhouk; 1 ♀, Saudi Arabia, Wadi Hanifa, 7.II.1976, W. Büttiker.

This species was first described by Puton (1895) from Aden. Subsequently it was reported from many other countries (Slater 1964a). China (1935) described a number of subspecies of this taxon and commented that the nominal subspecies had only been reported from Aden. Hoberlandt (1951) described a new subspecies from Palestine. Included in that paper was a key to the subspecies of *P. fallaciosus* (Puton), prepared by China, that indicated the distribution of the nominal species as SW Arabia (Aden). We have studied thirteen specimens of this subspecies from Saudi Arabia.

This species can be distinguished from other Lygaeinae by the characters given in the key. The subspecies differs from others in having brown veins in the hemelytral membrane, in having no or very little pink markings (mostly on the median pronotal carina) and in having a dark brown clavus and corium except for the costal margins.

Known distribution: Many workers have reported *fallaciosus* from different countries (Slater 1964a) but perhaps none of them except those from Arabia refer to the nominal subspecies. Slater (1964a) also states Iran as the type locality, perhaps in error.

***Spilostethus furculus*** (Herrich-Schaefer, 1850)

*Lygaeus festivus* Billberg, 1820. – Enum. Ins. Mus. Billberg: 68 (preoccupied).

*Lygaeus furcula* Herrich-Schaefer, 1850. – Wanz. Ins. *9:* 197.

*Spilostethus furcula.* – Slater 1964; South Afr. Anim. Life *10:* 32.

*Spilostethus furculus.* – Slater 1964; Cat. Lyg. World *1:* 196.

Material: Saudi Arabia, Riyadh: 1 ♂, 9.V.81 and 1 ♀, 1.XI.80; 1 ♀, 24.V.1981, W. Büttiker.

This species was first reported from Guinea (Billberg 1820). Subsequently it was reported from South Africa and several African and Southern European localities. It has not been reported from the Middle East. We have three specimens of this species from Saudi Arabia in the present material.

The species can be identified by its uniformly dark brown or black wing membrane, laterally broadly expanded black fascia on corium, and uninterrupted longitudinal black stripe on pronotum.

Known distribution: East, Central, South and West Africa, Algeria, Benin, Ethiopia, Europe, Guinea, Kenya, Madagascar, Mascarene Is., Morocco, Mozambique, Nigeria, Ruanda, Saudi Arabia (new record), Sierra Leone, Spain, Uganda, Zaire.

***Spilostethus longulus*** (Dallas, 1852)

*Lygaeus longulus* Dallas, 1852. – List Hem. B.M. *2:* 545.

*Lygaeus (Spilostethus) longulus.* – Stal 1868; Hem. Fabr. *1:* 75.

Material: Saudi Arabia: 1 ♀, Ar-Rass, 15.V.78, A.S. Talhouk; 2 ♂♂, Irq-Ratimah, 3.XII.1976, W. Büttiker; 1 ♀, Jeddah-Taif, 1200–1800 m, 1.V.1979; 1 ♂, Khashm Khafs, 15.III.1981, W. Büttiker; 2 ♂♂, Kushm Dibi, 20.IV.78, W. Büttiker; 1 ♀, Riyadh, 1.VIII.78, A.S. Talhouk; 1 ♂, 1 ♀, 70 km N Riyadh, Malhim, VIII.77, C. Besnard; 1 ♀, Riyadh Umg., 18.II.1975, W. Büttiker; 1 ♀, Riyadh Umg., 14.III.1975, W. Büttiker; 1 ♂, 1 ♀, Suwaydarah, 910 m, 30.IV.1981, W. Büttiker; 1 ♂, Wadi Araida b. Hair, 9.V.1975, W. Büttiker; 1 ♂, Wadi Awsat, 10.VIII.1978, W. Büttiker; 1 ♀, Wadi Awsat, 18.II.1977, W. Büttiker; 1 ♂, Wadi Mahjarish, 1000 m, 7.I.1983, W. Büttiker; 1 ♂, W. Shaib Luha, 27.VI.1976, W. Büttiker.

This species was originally described from Egypt (Dallas 1852). Subsequently it has been reported from many other countries including Arabia (Reuter 1890, Gulde 1920). We have a long series of this species in the present material.

This species can be identified because of its almost entirely red head, black anterior pronotal margin and two longitudinal black fascia in the posterior two-thirds of the pronotum, that are usually not connected to the black markings on the anterior pronotal margin. The scutellum is black with a red apex. The clavus is red with a black apex and a pair of distinct black circular spots. The red corium has a black transverse fascia that extends almost the entire width of the corium. The wing membrane is dark brown with a white oval spot and white areas along the basal angle and margin. Thoracic pleura are entirely black. The abdominal venter is red with four or more black spots along the lateral margins.

Known distribution: Aden, North Africa, Algeria, Arabia, Egypt, Ethiopia, India, Iran, Libya, Morocco, Nigeria, Pakistan, Palestine, Sahara, Sudan, Tunisia.

***Spilostethus pandurus pandurus*** (Scopoli, 1763)

*Cimex pandurus* Scopoli, 1763. – Ent. Carn. Exhib. Ins. Carniol. *368:* 126–127.

*Spilostethus pandurus.* – Oshanin 1912; Kat. Pal. Hem.: 27.

This species was first described from Italy (Scopoli 1763). Subsequently it has been reported from a large number of other countries including Arabia (Bergroth 1893). We do not have representatives of the nominal subspecies in the present material. It is also not possible for us to ascertain if Bergroth's material actually belonged to this subspecies.

This subspecies can be distinguished from related forms because of the uniformly translucent wing membrane.

Known distribution: West, North and South Africa, Albania, Algeria, Arabia, Australia, Austria, Balearic Is., Bulgaria, Burma, Canary Is., Cape Verde Is., Capraia Is., Caucasus, Corsica, Crete, Crimea, Cyprus, Czechoslovakia, Egypt, Ethiopia, France, Germany, Greece, Guinea, Hungary, India, Iran, Iraq, Italy, Kenya, Lebanon, Lesbos, Libya, Madeira Is., Malta, Mauritius, Morocco, Nigeria, Palestine, Philippine Is., Portugal, Russia, Sardinia, Senegal, Sicily, Sierra Leone, Somaliland, Spain, Sri Lanka, Sudan, Switzerland, Syria, Tanganyika, Tunisia, Turkey, Yugoslavia.

***Spilostethus pandurus militaris*** (Fabricius, 1775)

*Cimex militaris* Fabricius, 1775. – Syst. Ent.: 717.

*Lygaeus pandurus* var. *militaris* Horvath, 1898. – Rev. d'Ent. *17:* 149.

*Spilostethus pandurus* var. *militaris.* – Fuente 1920; Bol. Soc. Esp. (1920): 316.

Material: Saudi Arabia: 1 ♂, Riyadh, 6.VI.78, A.S. Talhouk; 1 ♂, 7.VI.78, A.S. Talhouk; 1 ♂, Riyadh Umg., XI.1976, W. Büttiker; 1 ♂, 1 ♀, Riyadh, 17.V.79, A.S. Talhouk; 1 ♀, Riyadh, 28.VII.79, A.S. Talhouk; 1 ♂, Riyadh, 13.V.80, A.S. Talhouk; 1 ♂, 1 ♀, Riyadh, 12.V.81; 1 ♂, Jeddah, 30.VIII.79, W. Büttiker; 1 ♂, Jizan, 20.I.79, A.S. Talhouk; 1 ♂, Al-Kharj, 26.IV.78, A.S. Talhouk; 1 ♀, Al-Kharj, 25.IX.81, A.S. Talhouk.

This subspecies was first described from the Orient. Subsequently it has been reported from many countries in Europe, the Middle East, Asia and Africa, but not from Saudi Arabia. We, however, suspect that some, if not all, of the records under *S. pandurus* from Saudi Arabia are probably based on this subspecies. We have 13 specimens in the present material.

The subspecies can be easily distinguished from other subspecies by its large body size (14 mm or more). The head is red dorsally except for the tylus and mesal area adjacent to eyes, which are black. The pronotum is red and black. The scutellum is entirely black. The clavus is red except for a pair of black round spots situated towards its apex. The corium is red but with black markings and a black transverse band that extends its entire width. The membrane is dark brown with an oval median spot and three irregular areas near the basal margin are white. Antennae, labium and legs are dark brown to black. The thoracic pleura are black with red discal areas.

Known distribution: East, Central, North and South Africa, Albania, Algeria, Australia, Austria, Belgium, Bengal, Bulgaria, Burma, Cameroons, Canary Is., Caucasus, Corsica, Crete, Cyprus, Czechoslovakia, Egypt, Ethiopia, France, Germany, Greece, Guinea, India, Indonesia, Iran, Iraq, Italy, Lebanon, Libya, Madeira Is., Majorca, Malta, Mascarene Is., Morocco, Mozambique, Namibia, Pakistan, Palestine, Philippines, Portugal, Romania, Russia, Sahara, Sardinia, Saudi Arabia (new record), Senegal, Sicily, Sierra Leone, Spain, Sri Lanka, Sudan, Switzerland, Syria, Tunisia, Turkey, Yugoslavia, Zimbabwe.

***Spilostethus rivularis epimetheus*** Linnavuori, 1974

*Spilostethus rivularis epimetheus* Linnavuori, 1974. - Acta Ent. Fenn. *30:* 23-24.

Material: Saudi Arabia: 3 ♀♀, Village Qaraah, 16.IV.1976, W. Wittmer & W. Büttiker.

This subspecies has been described by LINNAVUORI (1974) from Sudan, Yemen and South Yemen. This remains its known distribution. We have three specimens of this taxon in the present material as described above.

The subspecies can be identified by its relatively small size (9.9-11.5 mm long). There is a bifid, inverted Y-shaped red marking on the head. The pronotum is mostly black with five red areas; lateral margins are also black. The black scutellum has a red apex. The hemelytra have three red and three black longitudinal stripes; the black stripes are wider than the red; the outermost black stripe does not reach the base of the corium. The wing membrane is translucent white. Thoracic pleura are black, each with one oval red area; propleura have an additional elongate red area near the posterior dorsal angle. The abdominal venter has red and black transverse stripes, the black stripes being wider than the red. Antennae, labium and legs are black.

Known distribution: Saudi Arabia (new record), Sudan, Yemen.

***Spilostethus saxatilis*** (Scopoli, 1763)

*Cimex saxatilis* Scopoli, 1763. - Ent. Carn. Exhib. Ins. Carniol.: 128, 371.

*Lygaeus (Spilostethus) saxatilis.* - Stal 1868; Hemip. Fabr. *1:* 75.

This species was originally described by SCOPOLI (1763) from Italy. Since then it has been reported from many localities throughout Europe, northern Africa, the Middle East and eastward to Pakistan. It has not actually been reported from Saudi Arabia, but is very likely to occur there.

***Stenaptula angusticollis*** (Lindberg, 1939)

*Apterola angusticollis* Lindberg, 1939. - Bull. Soc. Fouad Ent. *22:* 13-14.

*Stenaptula angusticollis.* - Seidenstucker 1964; Reichenbachia *2:* 204.

*Apteroloides angusticollis.* - Slater 1964; South Afr. Anim. Life *10:* 61.

*Stenaptula angusticollis.* - Linnavuori 1978; Acta Zool. Fenn. *153:* 52.

Material: Saudi Arabia, BAC Camp, Khamis Mushayt, 2000 m, 14.-18.IV.1976, W. Wittmer & W. Büttiker.

This species was first described from Egypt (LINDBERG 1939). Subsequently it was reported from South Africa (SLATER 1964b), Sudan (LINNAVUORI 1978) and Nigeria (HAMID & HAMID 1983). The single specimen that we studied was reported by LINNAVUORI & ALAMY (1982) as *Stenaptula* sp. from Saudi Arabia. Although coloration and other characters of this specimen do not exactly match Lindberg's description and Slater's subsequent addition, we are tentatively regarding it as conspecific. Further material is needed to decide its status.

This specimen has a reddish brown head instead of black. The pronotum is reddish brown, lighter than the head, and the anterior margin is paler. The wing pads and scutellum are reddish brown, only slightly lighter than the pronotum. The seventh abdominal tergite is black; others are pale yellow with

a broad median black stripe and a pair of small darkened areas on the lateral sides. Measurements are as follows: length head 0.84 mm, width head 0.96 mm, interocular space 0.71 mm, median length pronotum 0.84 mm, maximum width pronotum 1.09 mm, length scutellum 0.38 mm, width scutellum 0.84 mm, length wing pads 0.42 mm, length antennal segments I 0.29 mm, II 0.67 mm, III 0.50 mm, IV 0.71 mm, total length body 4.49 mm.

Known distribution: Egypt, Nigeria, Saudi Arabia, South Africa, Sudan.

***Tropidothorax sternalis saudiensis*** n. ssp.

Material: Holotype, ♂, Saudi Arabia, Wadi Uqdah, 24°11'N 38°15'E, 11.–12.II.1980, W. Büttiker, NHMB.

The genus *Tropidothorax* is widely distributed in the Old World but its species concept is not very clear. The genus needs to be revised.

The nominate species, *Tropidothorax sternalis* (Dallas), was described from West Africa. Hamid & Meher (1976) reported it from Pakistan. Linnavuori (1978) reported it from Sudan. The only specimen we have before us from Saudi Arabia certainly belongs in this species but shows enough differences to justify a new subspecies. It differs from the West African specimens in having a black head, except for a paler, basal median area. The brown areas on the pronotum continue laterally and join the brown spot on the propleuron. The pronotal brown spot has uniform anterior margins. The brown spot on the corium is almost circular. The body is covered with longer hairs. Body measurements are as follows: length head 0.63 mm, width head 1.47 mm, length pronotum 1.47 mm, width pronotum 2.42 mm, length scutellum 0.84 mm, length corium 3.57 mm, length antennal segments I 0.53 mm, II 1.47 mm, III 1.26 mm, IV 1.73 mm, total length body 7.35 mm.

***Tropidothorax wittmeri*** n. sp.

Material: Holotype, ♀, Saudi Arabia, W. Shuqub/Turabah, 1250 m, 21.IV.1980, W. Büttiker, NHMB.

Last two segments of the right antenna are broken but are glued to the same card that the specimen is on.

Apex of tylus and vertex except area adjacent to ocelli black, area adjacent to ocelli and most other head areas dull yellow with some red areas, antenna black. Anterior half of pronotum and median carina red, posterior half black and dull yellow, black areas extending from calli to posterior margin as two triangles with three yellow areas, one in the middle and two on sides; black area near posterior outer angle curving forward along shoulders to one-fifth of pronotum. Scutellum black; clavus and corium yellow; wing membrane black with a median oval spot and a basal triangular area white. Legs and labium black, apical half of antennal tubercle and area between tubercle and tylus dark brown, bucculae yellow. Propleuron red in anterior half and yellow in posterior half; meso- and metapleura with interspersed black and yellow areas, metapleuron more black than mesopleuron. Metathoracic scent gland auricle yellow. Abdominal venter yellow in anterior half and red in posterior half; genital segments darker.

Head convex, broader than long; pronotum with lateral sides somewhat concave anteriorly, posterior margin slightly produced caudad, median carina and lateral sides elevated; scutellum tumid in posterior two-thirds. Dorsal side of head, pronotum, scutellum, hemelytra, antenna and legs covered with long straight brown hairs, those on hemelytra shorter than other parts; ventral side of body with short declivent hairs. Body measurements are as follows: length head 1.0 mm, width head 1.55 mm, length pronotum 1.85 mm, maximum width pronotum 2.86 mm, length scutellum 1.18 mm, width scutellum 1.26 mm, length corium 4.12 mm, length membrane 4.20 mm, length antennal segments right

side (left oligometric with only two segments) I 0.55 mm, II 1.60 mm, III 1.22 mm, IV 1.51 mm, total length body 8.72 mm.

This species is named after Dr. W. Wittmer, who has contributed much to the knowledge of the Saudi Arabian insect fauna.

## ACKNOWLEDGEMENTS

This study was made possible because of the excellent cooperation we received from Dr. W. Wittmer and Dr. M. Brancucci of the Natural History Museum, Basel. Dr. J. A. Slater of the University of Connecticut, Storrs, Connecticut, U.S.A. and Mr. W. R. Dolling of the British Museum (Natural History), London, helped in confirming some of the identifications. Dr. R. Linnavuori provided information about some species of Lygaeidae from Saudi Arabia. Their cooperation and help is gratefully acknowledged.

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# Sternorrhyncha: Suborder Psyllodea of Saudi Arabia (Part 2)

**D. Burckhardt**

Abstract: Twenty-four species are recorded from Saudi Arabia, nine for the first time. Two species are described as new: *Acizzia marginata* n. sp. from *Acacia* and *Albizia* spp., and *Cacopsylla talhouki* n. sp. The larvae of six species are described for the first time and information on adult morphology and host plants of some species is included.

Keywords: Sternorrhyncha, Psyllodea, Saudi Arabia, taxonomy.

قمليات النبات النطاطة (Sternorrhyncha: Psyllodea) في المملكة العربية السعودية

(الجزء الثاني)

د. بركهاردت

خلاصة : تم تسجيل ٢٤ نوعا من المملكة العربية السعودية ، ٩ منها سجلت لأول مرة . كذلك تم وصف نوعين جديدين وهما Acizzia marginata n.sp. من نباتات من أنواع Acacia و Albizia و Cacopsylla talhouki n. sp. . وتم وصف المراحل اليرقية لستة انواع لاول مرة كما احتوى المقال على معلومات تتعلق بشكل الحشرة البالغة والنباتات المعيلة لها .

## INTRODUCTION

The jumping plant lice or psyllids, a group of sap-sucking homopterous insects, are well represented in the eremic regions of the USSR and Mongolia (Klimaszewski 1973). A similarly diverse fauna is to be expected from Northern Africa and the Arabian peninsula. However, only 13 species have been recorded from Saudi Arabia (Burckhardt 1981, Hollis 1984, Martin 1972). Recent collections made by the KAU-NHMB expedition to the Northern Hedjaz in 1979 and, in particular, by A. S. Talhouk during the last few years, contain interesting material, which initiated this study. In addition to a revised list of Saudi Arabian psyllids, some information on larvae and host plants is included.

The classification used is that of White (1980) and White & Hodkinson (1985). Morphological terminology mainly follows Hodkinson & White (1979), Hollis (1976,1984) and White & Hodkinson (1982); the nomenclature of the female terminalia is according to Burckhardt (1985a).

The material studied is deposited in the Naturhistorisches Museum, Basel (NHMB), the British Museum (Natural History), London (BMNH), the Muséum National d'Histoire Naturelle, Paris (MNHN) and in the collections of A. S. Talhouk (AST) and of the author (DB).

## SYSTEMATIC PART

### Fam. **Aphalaridae**

***Caillardia dilatata*** Loginova, 1978 (figs 1-4)

*Caillardia dilatata* Loginova, 1978b: 20.

Distribution: Previously recorded from Egypt, Iran (Loginova 1978b) and Saudi Arabia (Burckhardt 1981). Additional material examined: Saudi Arabia: several larvae of different instars, 111 km before Al Ula, 860 m, 21.IV.1979, *Hammada* sp., KAU-NHMB 1979 Exp. N. Hedjaz, NHMB, DB; 2 ♂, 4 ♀, 9 larvae, Al-Kharj, 1.V.1983, *Hammada salicornica*, A. S. Talhouk, AST, DB; 2 ♂, 1 ♀, 19 larvae, Jubail, 28.III.1984, in leaf galls of *Hammada elegans*, A. S. Talhouk, AST, DB.

Description: Larva. Coloration. Cephalic sclerites brown, compound eyes yellowish orange, head ventrally pale yellow to greyish. Antennae basally brown, in the middle yellow, apically light brown. Clypeus dark brown. Body yellow to greyish, abdominal tergites, dorsal surface of wing pads and caudal plate dark brown. Legs brown. The whole body is covered with a thin layer of white waxy excretion.

Structure. Body (fig. 1) elongate, robust, including wing pads 0.8-1.0 times broader than long; sparsely covered with short setae dorsally. Antennae (fig. 2) 0.4-0.5 times longer than forewing pads; usually 8-segmented, bearing one rhinarium on segments 4 and 6, and 2 rhinaria on segment 8, or sometimes 9-segmented with a single rhinarium on segments 4, 6, 8 and 9, occasionally with more rhinaria; apical segment with a pair of short thick terminal setae; segments 2, 6,7 and 8 bearing elongate lanceolate setae. Thorax with strongly reduced tergites. Legs sparsely setaceous. Tarsal arolium (fig. 3) short, oval, without visible unguitractor. Forewing-pads with small humeral lobes. Body margin with following numbers of irregularly spaced and sized, elongate lanceolate setae (one side only): forewing pads 21 (14-27), hindwing pads 10 (5-16) and abdomen 23 (19-34). Abdominal tergites medium large; caudal plate anteriorly in the middle strongly incised, 1.8-2.0 times broader than long. Outer circumanal ring (fig. 4) 0.3-0.4 times broader than caudal plate, consisting of several rows of pores, the inner elongate and relatively regular, the outer rather rounded and irregular.

Measurements (10 specimens). Antennae length 0.39-0.49 mm; forewing pad length 0.82-1.13 mm; body length 2.01-3.47 mm; caudal plate breadth 0.88-1.37 mm.

Host plants: *Hammada elegans* (Bunge) Botsch., *H. salicornica* (Moq.) Iljin, *Hammada* sp. (Chenopodiaceae). The larvae form galls on the leaves.

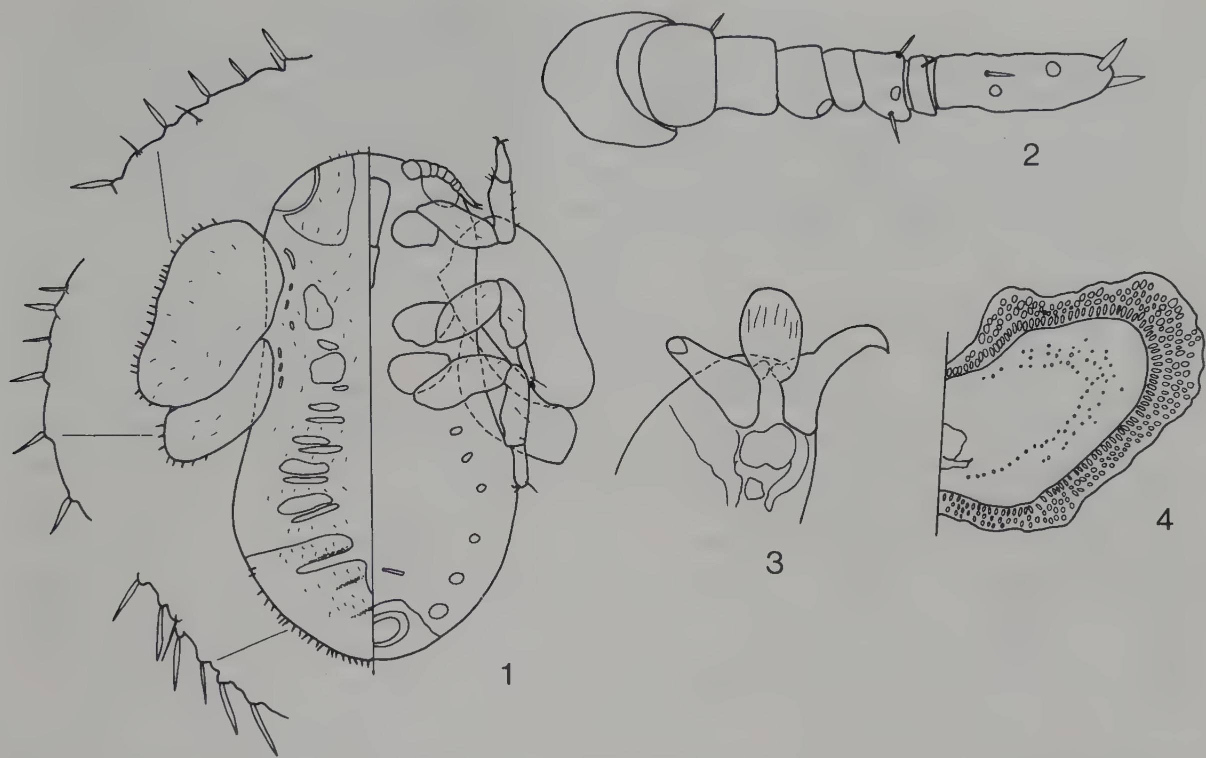
***Caillardia inedita*** Loginova, 1978

*Caillardia inedita* Loginova, 1978b: 17.

Distribution: Recorded from the USSR: Kazakh SSR, Turkmen SSR and Uzbek SSR. Material examined: Saudi Arabia: 3 ♂, 4 ♀, 8 larvae, Wadi Dawasir, 10.III.1984, *Haloxylon persicum*, A. S. Talhouk, AST, DB.

Description: Larva. Coloration. Cepahlic and thoracic sclerites, antennae, legs and wing pads light brown. Clypeus and caudal plate lighter or darker brown. Rest of body yellow to ochreous. Abdomen covered with white waxy excretion.

Structure. Similar to *C. anabasidis* Loginova and *C. robusta* Loginova as described and figured by Loginova (1982). Body elongate, 0.6-0.7 times broader than long; on dorsum sparsely covered with short setae. Antennae 8-segmented, 0.4-0.7 times longer than forewing pads; bearing a single rhinarium on segments 4, 5, 6 and 7, and 2 rhinaria on segment 8; rhinaria on segments 5 and 7 smaller than the remaining ones, sometimes almost entirely reduced. Legs as in *C. dilatata* Loginova. Forewing pads only with very small humeral lobes. Margin of wing pads without lanceolate setae; margin of abdo-




Figs 1–4: *Caillardia dilatata* Loginova, 5th instar larva: 1, left dorsal view, right ventral view. 2, antenna. 3, apex of tarsus. 4, circumanal ring.

men (one side only) with 32 (21–37) elongate, more or less evenly spaced lanceolate setae. Caudal plate terminally somewhat angular, 1.4–1.6 times broader than long. Outer circumanal ring 0.2 times broader than caudal plate, consisting of a single row of pores.

Measurements (8 specimens). Antennae length 0.36–0.42 mm; forewing pad length 0.60–0.96 mm; body length 2.14–2.59 mm; caudal plate breadth 0.69–0.87 mm.

Host plants: *Haloxylon aphyllum* (Minkw.) Iljin, *H. persicum* Bunge, ex Boiss. & Buhse (Chenopodiaceae).

***Rhombaphalara achaetae*** (Klimaszewski, 1967) (figs 5–13)

*Rhodoclanis achaetae* Klimaszewski, 1967: 46.

*Rhombaphalara achaetae* (Klimaszewski); Loginova 1972: 269.

Distribution: Recorded from Mongolia and the USSR: Kazakh SSR (Klimaszewski 1967, Loginova 1972). Material examined: Saudi Arabia: 29 ♂, 38 ♀, 33 larvae of 4th and 5th instar, Wadi Dawasir, 20.XI.1983, *Suaeda fruiticosa* , A. S. Talhouk, AST, DB.

Description: Adult. Coloration. Head yellow. Antennal segments 1 and 9 ochreous, 2–8 yellow, 10 brown. Thorax ochreous. Forewings semitransparent to opaque, yellow, with indistinct brown spots apically in more mature specimens. Abdomen yellow.

Structure. Head from above (fig. 5) slightly wider than pronotum, as wide as mesoscutum, hind margin almost straight; in profile, inclined at about 45° to longitudinal axis of body. Vertex flat with slightly indented foveae, almost rectangular, in front separated from the genae by a transverse groove on either side of the median ocellus. Genae slightly produced, in front bearing some medium-long setae. Antennae 10-segmented, 0.7–0.8 times longer than head width, with a single subapical rhinarium on

segments 4–9; segment 10 terminally with a pair of subequal, medium-long truncate setae; flagellar segments with a few setae about as long as segmental width. Clypeus flattened pyriform; apical 2 labial segments 0.2–0.3 times longer than head width. Thorax, in profile, strongly arched. Pronotum rectangular, relatively long. Propleurites broad, with both dorsal branches of suture well-developed; episternum and epimeron with subequal surface areas. Legs short and robust. Metacoxae with papilliform meracanthus; metatibiae 0.5–0.6 times longer than head width, without basal spine, with 5–7 grouped short apical spurs (4–6 inner and 1 outer). Forewings (fig. 6) rhomboidal, 2.6–3.1 times longer than head width, 2.1–2.2 times longer than wide, maximal width basally; without costal break, pterostigma narrow, indistinctly delimited from cell r1; surface spinules present only in a narrow area along the outer and posterior wing margin; membrane sparsely covered with very short setae. Fore margin of cell c+sc angular and, distally to the bent indented, in females more pronounced than in males. Cell cu1a 1.2–1.8 times wider than high. Hindwings shorter than forewings, membranous; vein Cu1 basally indistinct, branching off vein R+M+Cu1 first, costal setae ungrouped. Terminalia as in figs 7–11. Male proctiger 0.3 times longer than head width, with long lateral lobes bearing basally an inward directed hook; covered with long setae. Parameres club-shaped, longer than proctiger, with a thumb-like subapical projection on fore margin; inner surface at base of projection sculptured; terminally sclerotized, sparsely haired. Proximal portion of aedeagus in apical part slightly bent backwards; distal portion a little longer than proctiger, straight, with strongly dilated apex. Sclerotized end tube of ductus ejaculatorius long, almost straight. Female proctiger 1.2–1.3 times longer than head width; dorsal margin in the middle angular, apically thickened, truncate, 2.8–3.7 times longer than circumanal ring, which consists of 2 unequal rows of pores; distal to the circumanal ring with sclerotized callus. Subgenital plate 0.5–0.6 times longer than circumanal ring. Valvulae 1 terminally blunt, valvulae 2 cuneate.

Measurements (4 ♂, 4 ♀). Head width 0.58–0.64 mm; antennae length 0.40–0.47 mm; forewing length 1.58–1.94 mm; proctiger length ♂ 0.20–0.21 mm, ♀ 0.75–0.80 mm; paramere length 0.23–0.24 mm; length of distal portion of aedeagus 0.22–0.23 mm.

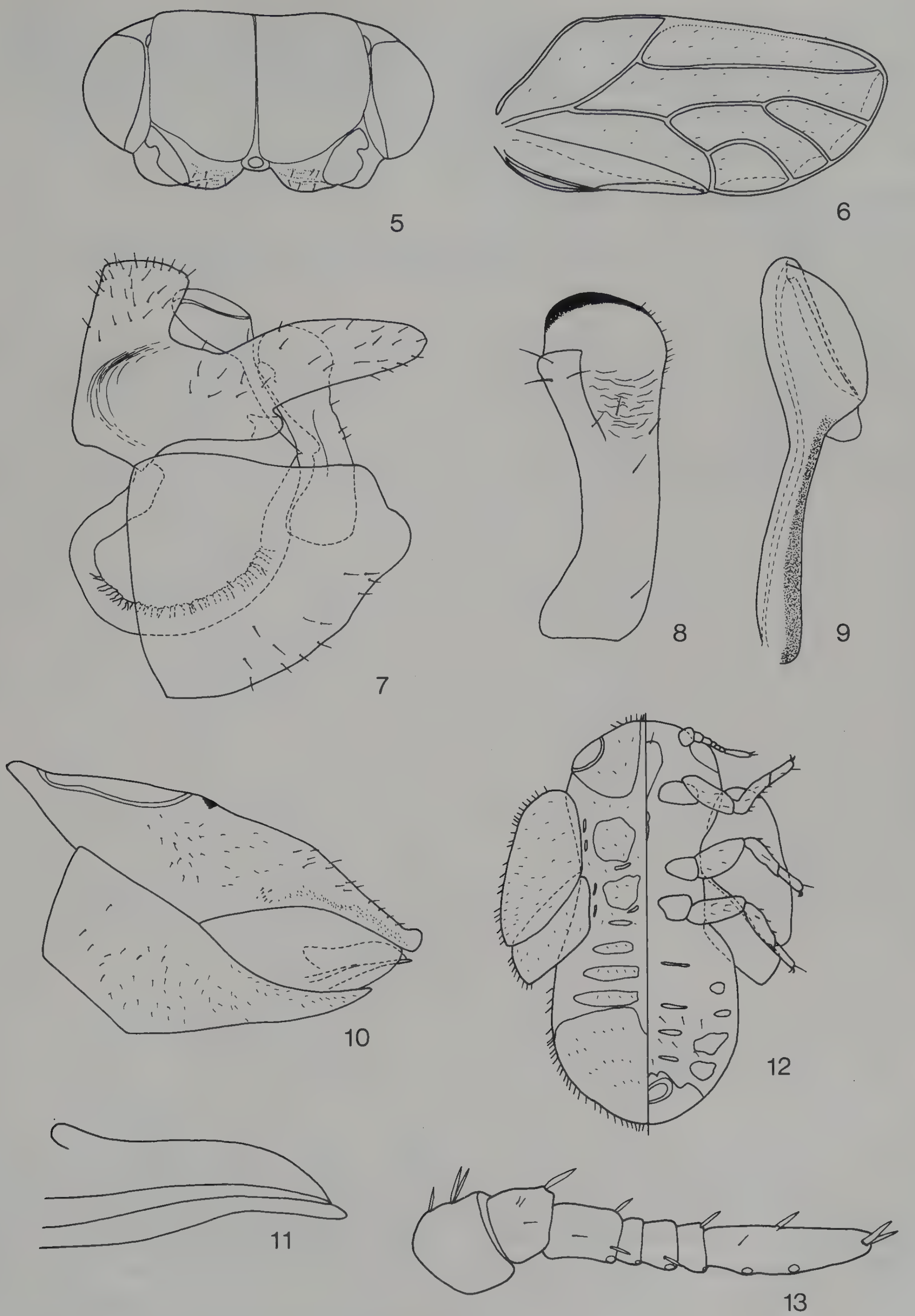
Larva. Coloration. Head and body yellow. Cephalic and thoracic sclerites dorsally light brown. Forewing pads with a smaller anterior and a larger posterior brown patch, hindwing pads with one large dorsal brown patch. Abdominal sclerites dorsally dark brown. Tips of antennae and labium dark brown. Body dorsally covered with white waxy excretion.

Structure. Similar to *Caillardia dilatata*, but body more flattened. Body (fig.12) elongate, including wing pads 0.7–0.8 times broader than wide; covered with short setae. Antennae (fig. 13) 7–8-segmented, 0.5 times longer than forewing pads, with 6 rhinaria, 1 on segments 3–6 and 2 on 7, or 1 on segments 3–8; with several elongate lanceolate setae. Thoracic tergites large. Legs sparsely haired; tibiotarsi with elongate lanceolate setae. Tarsal arolium short, oval without visible unguitractor. Forewing pads with inconspicuous humeral lobes. Body margin with following number of irregularly spaced, elongate lanceolate setae (one side only): head 7 (6–7), forewing pads 25 (23–29), hindwing pads 8 (6–9), abdomen 26 (22–30). Abdominal tergites large; caudal plate 1.5–1.8 times broader than long, anteriorly in the middle strongly incised. Abdominal sternites small, terminal plate bearing circumanal ring weakly slerotized, in front exceeding circumanal ring only a little. Outer circumanal ring 0.3 times broader than caudal plate, consisting of several rows of pores, similar to *Caillardia dilatata*.

Measurements (8 specimens). Antennae length 0.30–0.36 mm; forewing pad length 0.62–0.73 mm; body length 1.51–1.88 mm; caudal plate breadth 0.40–0.50 mm.

Host plants: *Kalidium* sp., *Suaeda fruiticosa* Forsskål ex J. F. Gmel. (Chenopodiaceae).

Comments: The Saudi Arabian material differs from the original description in the shape of the forewings. However, this character is variable in members of the Caillardiini.




Figs 5–13: *Rhombaphalara achaetae* (Klimaszewski): 5, head, dorsal view. 6, forewing. 7, ♂ terminalia, lateral view. 8, paramere. 9, distal portion of aedeagus. 10, ♀ terminalia, lateral view. 11, valvulae 1 and 2. 12, 5th instar larva, left dorsal view, right ventral view. 13, antenna.

LOGINOVA (1972) transferred *achaetae*, originally described in *Rhodoclanis*, to *Rhombaphalara*. Whereas wing structure and coloration in *achaetae* correspond with other species of *Rhodoclanis*, the structure of the parameres shows more similarity to members of *Rhombaphalara*. Without a revision of the whole tribe Caillardiini, it is not possible to indicate the phylogenetic relationships of the species, and the classification of LOGINOVA (1972) is followed.

***Euphyllura obsoleta*** Mathur, 1975 (figs 14–22)

*Euphyllura obsoleta* Mathur, 1975: 238.

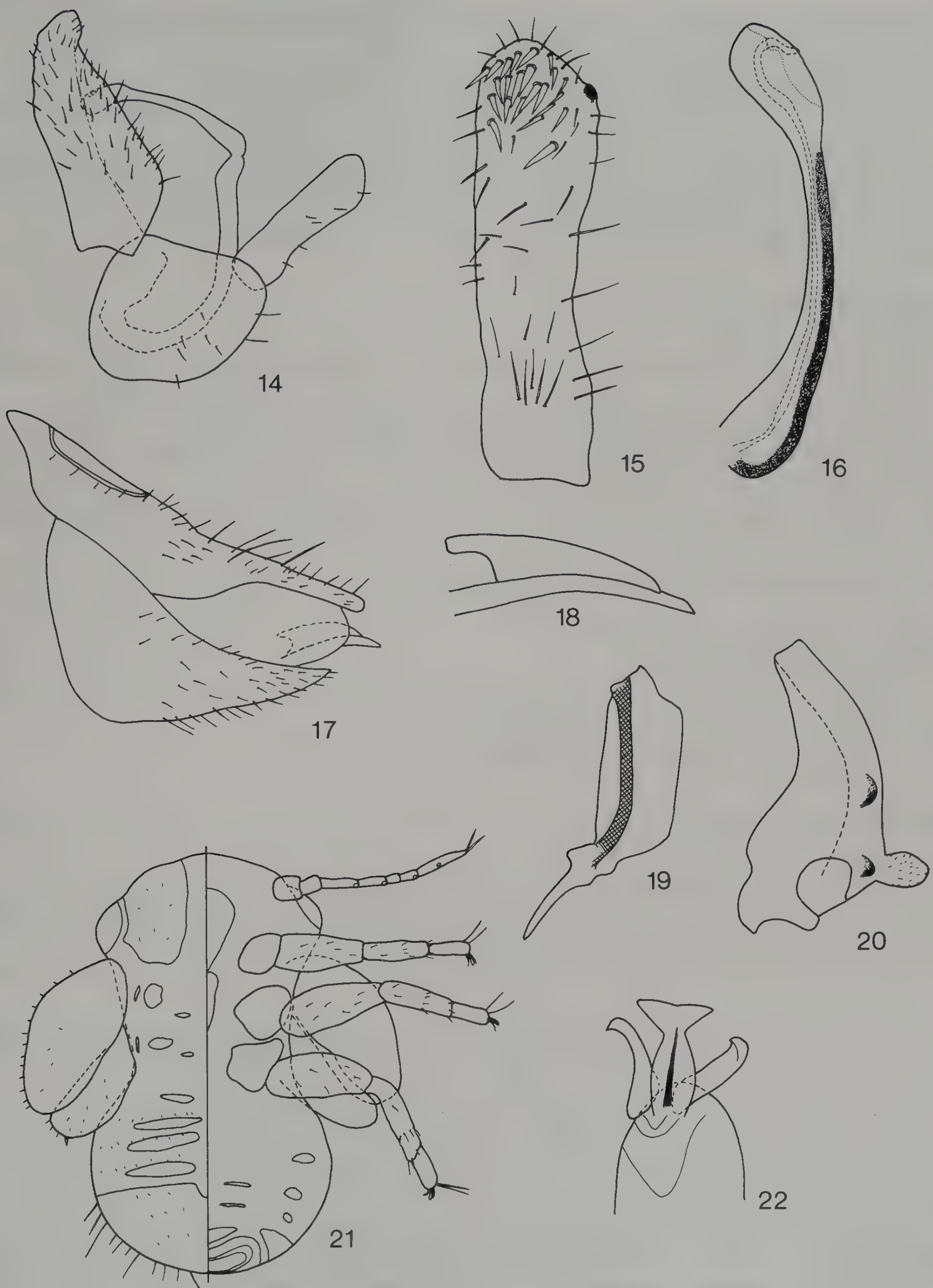
Distribution: Recorded from India: Dehli, Punjab, Rajasthan and Pakistan: Punjab (MATHUR 1975). Material examined: Saudi Arabia: 5 ♂, 10 ♀, Jizan, 7.II.1980, A. S. Talhouk, NHMB; 12 ♂, 11 ♀, 5 larvae, same, 19. XI.1981, AST, DB.

Description: Adult. MATHUR's otherwise fairly adequate description (1975) of the adult is supplemented by some characters which are considered to be of diagnostic or phylogenetic relevance. Antennae 0.9–1.0 times longer than head width; with 1–2 rhinaria on segments 4, 6, 8 and 9, in about half of the specimens also 1–3 rhinaria on segment 3, rarely also rhinaria on segments 5 and 7; relative length of flagellar segments from base to apex – 1.0 : 0.5 : 0.5 : 0.5 : 0.5 : 0.6 : 0.6 : 0.5. Clypeus pyriform; apical 2 labial segments 0.3–0.4 times longer than head width. Propleurites (fig. 19) very narrow; suture only with one dorsal branch; episternum smaller in surface area than epimeron. Metacoxae with papilliform, medium-long meracanthus and 2 humps on the outer side (fig. 20); metatibiae 0.6–0.7 times longer than head width, without basal spine, with a crown of 7 (6–8) regularly spaced, short apical spurs; basal metatarsi with 2 black spurs. Forewings 1.9–2.3 times longer than head width, 1.9–2.1 times longer than wide; surface spinules present in all cells, covering the whole cell surface, regularly spaced; membrane semitransparent, under low magnification with cellular structure. Hindwings shorter than forewings; costal setae ungrouped, but basally spaced denser; vein R+M+Cu1 branching in R+M and Cu1 or R and M+Cu1; veins M and Cu1 basally indistinct. Terminalia as in figs 14–18. Male proctiger 0.4–0.5 times longer than head width, covered with medium-long hairs, laterally in basal quarter angular; subgenital plate short. Parameres lamellar; inner surface apically with a group of long thick setae, subapically with a strongly sclerotized tubercle. Distal portion of aedeagus slightly curved, apically dilated. Sclerotized end tube of ductus ejaculatorius short, sinuate. Female proctiger 0.8–0.9 times longer than head width, 2.7–3.4 times longer than circumanal ring; dorsal margin straight or somewhat concave; subgenital plate cuneate, 0.6 times longer than proctiger. Valvulae 1 and 2 weakly curved.

Measurements (5 ♂, 5 ♀). Head width 0.56–0.65 mm; antennae length 0.51–0.61 mm; forewing length 1.10–1.38 mm; proctiger length ♂ 0.22–0.25 mm, ♀ 0.51–0.57 mm; paramere length 0.18–0.19 mm; length of distal portion of aedeagus 0.17–0.20 mm.

Larva. Coloration. Head and thorax yellow. Antennae yellow with brown apex. Tarsi brown. Abdomen ochreous.

Structure. Body (fig. 21) broad, flattened, including wing pads 0.9–1.0 times broader than long; dorsally covered with short setae. Antennae 1.1–1.2 times longer than forewing pads, 6–8-segmented, usually with 4 rhinaria; with a few setae about as long as diameter of flagellum, apically with a pair of long subequal setae. Thorax with strongly reduced tergites. Legs sparsely covered with medium long simple setae. Tarsal arolia (fig. 22) short, base wide, apical part trapezoid; unguitractor long. Forewing pads small, without humeral lobes; outer margin with short simple setae. Hindwing pads with a single pointed sectaseta. Abdomen with medium large tergites, margin with a number of long and very long simple setae. Caudal plate anteriorly in the middle somewhat incised, 2.2–3.1 times broader than long. Outer circumanal ring consisting medially of a single and laterally of 2–3 rows of pores, 0.3–0.4 times wider than caudal plate.




Figs 14–22: *Euphyllura obsoleta* Mathur: 14, ♂ terminalia, lateral view. 15, paramere. 16, distal portion of aedeagus. 17, ♀ terminalia, lateral view. 18, valvulae 1 and 2. 19, propleurite. 20, metacoxa. 21, 5th instar larva, left dorsal view, right ventral view. 22, apex of tarsus.

Measurements (4 specimens). Antennae length 0.47–0.55 mm; forewing pad length 0.41–0.48 mm; body length 0.93–1.16 mm; caudal plate breadth 0.50–0.59 mm.

Host plant: *Salvadora oleoides* Dene (Salvadoraceae).

Comment: MATHUR (1975) reluctantly included *obsoleta* in *Euphyllura*. The morphology of adults and larvae as well as the host plant range of *E. obsoleta* suggest there is no close relationship to the Oleaceae-feeding *Euphyllura* spp. Its true relationships, however, remain unclear, as adults and larvae show "aphalarid" and "psyllid" characters. This species might be related to primitive legume-feeding Psyllidae such as *Pachyparia*, but *obsoleta* is left for the moment in *Euphyllura*.

***Euphyllura olivina*** (Costa, 1839)

*Thrips olivinus* Costa, 1839: 23.

*Euphyllura olivina* (Costa); Aulmann 1913: 67, p.p.; Burckhardt 1983: 131; Klimaszewski 1973: 161, p.p.; Oshanin 1907: 340, p.p.

Distribution: Recorded from the whole of the Mediterranean region, however, recent investigations showed that *E. olivina* sensu AULMANN (1913), KLIMASZEWSKI (1973) and OSHANIN (1907) is a complex of two species (BURCKHARDT 1983, LOGINOVA 1973, STAVRAKI 1980): *E. olivina* s. str. in the Western and *E. straminea* Loginova in the Eastern Mediterranean. Reported from Saudi Arabia as an introduction from the Mediterranean (MARTIN 1972), but this record needs verification.

Host plants: *Olea europaea* L., *O. sylvestris* Miller (Oleaceae).

***Euphyllura aethiopica*** Silvestri, 1915

*Euphyllura aethiopica* Silvestri, 1915: 241.

Distribution: Previously recorded from Ethiopia (SILVESTRI 1915). Material examined: Saudi Arabia: 1 ♀, Abha, 15.VII.1981, A. S. Talhouk, AST.

Host plant: *Olea chrysophylla* Lam. (Oleaceae).

***Diaphorina bikanerensis*** Mathur, 1975

*Diaphorina bikanerensis* Mathur, 1975: 191.

Distribution: Previously recorded from India: Rajastan (MATHUR 1975). Material examined: Saudi Arabia: 14 ♂, 33 ♀, numerous larvae, Khureys Rd., 8.V.1984, *Leptadenia pyrotechnica*, A. S. Talhouk, AST, DB; 14 ♂, 10 ♀, numerous larvae, Dirab, 8.V.1984, *Leptadenia pyrotechnica*, A. S. Talhouk, AST.

Description: Larva. Coloration. Head and body ochreous reddish, wing pads yellow to ochreous. Eyes reddish brown. Tips of antennae and legs brown.

Structure. Conforming to generic description and illustrations by BURCKHARDT (1985b). Body sparsely covered with medium-long club-shaped setae, 0.9–1.0 times broader than long. Antennae 0.3–0.4 times longer than forewing pads; segment 3 with setae SC, SR1 and SR2. Outer margin of forewing pads curved. Margin of abdomen with 44 (40–46) caudal and generally without precaudal setae (occasionally with 1 or 2 on either side). Outer circumanal ring consisting of a single row of pores, 0.3 times broader than caudal plate.

Measurements (8 specimens). Antennae length 0.29–0.34 mm; forewing-pad length 0.85–0.92 mm; body length 1.53–1.70 mm; caudal plate breadth 0.70–0.80 mm.

Host plants: *Leptadenia pyrotechnica* Decne., *L. spartium* White (Asclepiadaceae). The larvae develop in the leaf axils.

***Diaphorina citri*** Kuwayama, 1908

*Diaphorina citri* Kuwayama, 1908: 160.

Distribution: Widely distributed throughout Asia and known from Mauritius, Reunion, Brazil

(Commonwealth Institute of Entomology 1974) and Hawaii (Sasaki 1954). Reported from Saudi Arabia by Burckhardt (1981).

Host plant: *Citrus mitis* Blanco., *C. reticulata* Blanco, *C. sinensis* (L.) Osbeck, *Murraya koenigii* Spreng, *M. paniculata* (L.) Jack (Rutaceae).

***Diaphorina enormis*** Loginova, 1978

*Diaphorina enormis* Loginova, 1978a: 61.

Distribution: Recorded from Iran, the Sudan (Loginova 1978a) and Saudi Arabia (Burckhardt 1981).

Host plant unknown.

***Diaphorina lamproptera*** Burckhardt, 1981

*Diaphorina lamproptera* Burckhardt, 1981: 215.

Distribution: Egypt and Saudi Arabia (Burckhardt 1981, 1985b).

Host plant: *Zygophyllum* cf. *album* L. fil. (Zygophyllaceae).

***Diaphorina linnavuorii*** Loginova, 1978

*Diaphorina linnavuorii* Loginova, 1978a: 76.

Distribution: Recorded from Ethiopia (Loginova 1978a). Material examined: Saudi Arabia: 23 ♂, 27 ♀, Abha, 15.VII.1981, A. S. Talhouk, AST, DB.

Host plant unknown.

## Fam. **Psyllidae**

***Pachyparia dimorpha*** Loginova, 1967

*Pachyparia dimorpha* Loginova, 1967: 402.

Distribution: Recorded from Saudi Arabia and the Sudan (Burckhardt 1981, Loginova 1967). Additional material studied: Egypt and Sudan , BMNH.

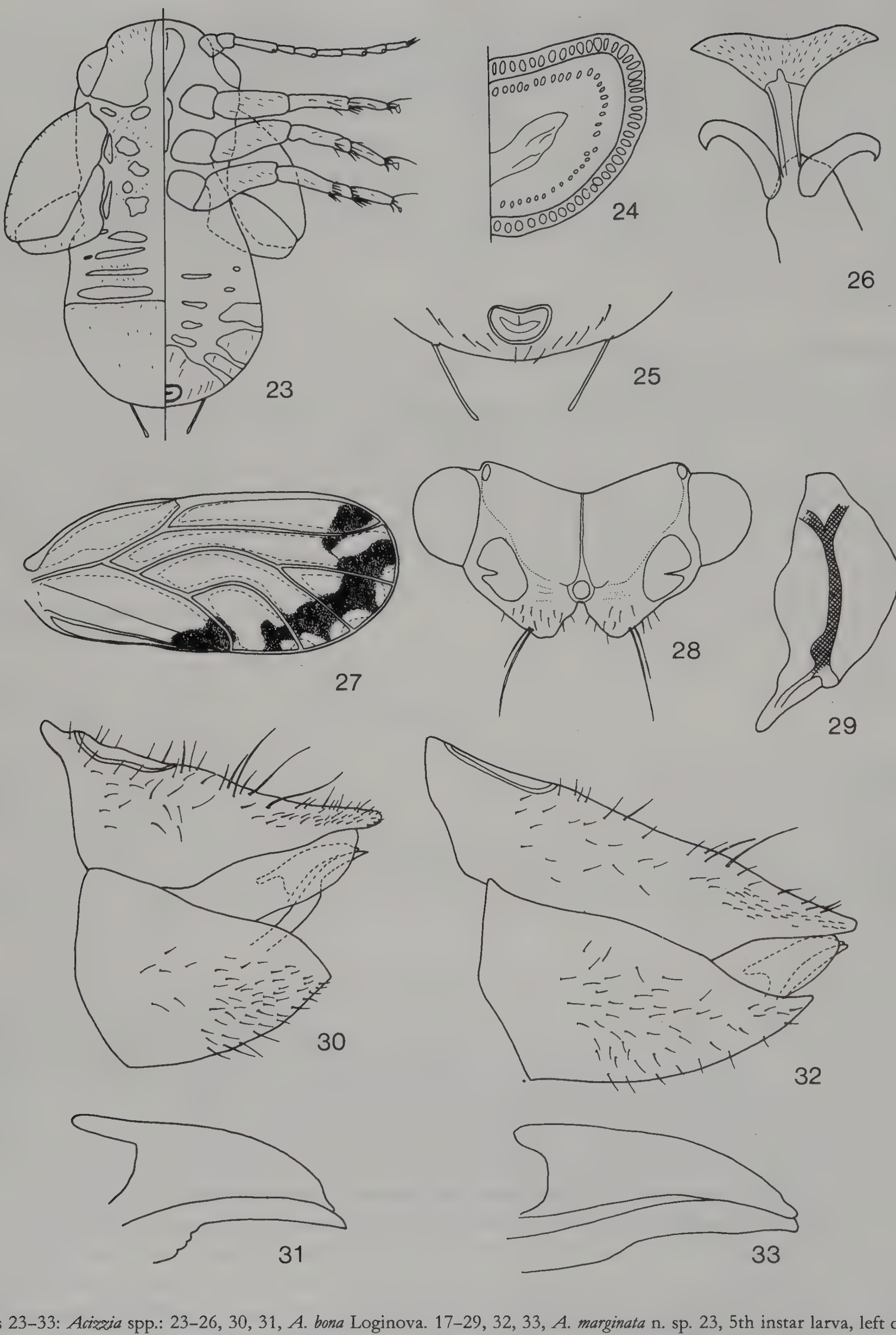
Host plants: *Acacia ehrenbergiana* Hayne, *A. nilotica* (L.) Willd. ex Del., *A. tortilis* (Forsskål) Hayne (Leguminosae).

***Acizzia bona*** Loginova, 1967 (figs 23–26, 30, 31, 34–36)

*Acizzia bona* Loginova, 1967: 407.

Distribution: Previously recorded from Saudi Arabia (Burckhardt 1981) and from the Sudan (Loginova 1967). Additional material examined: Saudi Arabia: 18 ♂, 7 ♀, several nymphs of different instars, Jizan, 2.III.1984, ex *Acacia ehrenbergiana*, A. S. Talhouk, AST, NHMB, DB.

Description: Adult. Forewings with surface spinules in all cells leaving free stripes along the veins; arranged in rings. Terminalia as in figs 30, 31, 34–36. Male proctiger with broad, irregularly rounded lateral lobes; apart from base, covered with medium long setae. Male subgenital plate long, dorsal margin concave, terminally covered with medium-long setae. Parameres in the middle of the fore margin with upturned hook; apical half of inner surface along fore margin with long thick setae; apex with truncate forward directed hump. Proximal portion of aedeagus in terminal part distinctly curved backwards; distal portion apically dilated and slightly curved; sclerotized end tube of ductus ejaculatorius medium-long and straight. Female terminalia cuneate; proctiger with some long setae dorsally, terminally with densely spaced short setae and basally with medium-long setae; dorsal margin




Figs 23–33: *Acizzia* spp.: 23–26, 30, 31, *A. bona* Loginova. 17–29, 32, 33, *A. marginata* n. sp. 23, 5th instar larva, left dorsal view, right ventral view. 24, 25, circumanal ring. 26, apex of tarsus. 27, forewing. 28, head, dorsal view. 29, propleurite. 30, 32, ♀ terminalia, lateral view. 31, 33, valvulae 1 and 2.

slightly sinuate. Female subgenital plate in distal half densely covered with medium-long setae; ventral margin convex. Valvulae 1 in distal part more or less straight, apically pointed, dorsal margin of valvulae 2 subapically indented.

Larva. Coloration. Dorsal sclerites of head, thorax, abdomen and wing pads dark brown; less sclerotized parts ochreous to reddish. Antennal segments 1 and 2 yellow, 3–7 basally yellow, apically almost black, 8–9 almost black. Clypeus ochreous; legs ochreous to brown, apices of tibiae and tarsi dark brown; ventral abdominal sclerites dark brown.

Structure. Body (fig. 23) elongate, including wing pads 0.8 times broader than long; dorsum sparsely covered with very short setae. Antennae 9-segmented, 1.2–1.5 times longer than forewing pads; bearing a single subapical rhinarium on segments 3, 5, 7 and 8; covered with a few setae shorter than width of segments; segment 9 with a pair of subequal medium long terminal setae. Clypeus in front with a pair of long simple setae, labium long. Thorax with small tergites. Legs covered with medium-long hairs; tibiotarsi in the middle and apically with crowns of long simple setae. Tarsal arolia (fig. 26) trapezoidal, outer margin in the middle indented; unguitractor longer than arolium. Forewing pads elongate, relatively short; outer margin rounded, hind margin angular. Abdominal sclerites medium large; ventral sclerites partially fused, with some medium long setae and densely spaced spinules. Caudal plate 1.7–2.0 times broader than long; hind margin on either side with 1–2 long slightly capitate setae (fig. 25). Outer circumanal ring (fig. 24) consisting of a single row of 42–53 elongate wax pores, 0.2 times broader than caudal plate.

Measurements (7 specimens). Antennae length 0.64–0.73 mm; forewing pad length 0.44–0.50 mm; body length 1.12–1.37 mm; caudal plate breadth 0.59–0.65 mm.

Host plants: *Acacia ehrenbergiana* Hayne, *A. seyal* Del. (Leguminosae).

Comment: According to the original description (Loginova 1967) the parameres possess a short longitudinal ridge on the inner surface and a bicuspid process in the middle of the fore margin. However, the ridge is on the outer surface of the parameres and the bicuspid structure in the middle of the fore margin constitutes the base of an upturned hook, which is apparently broken in the specimen described by Loginova.

***Acizzia marginata*** n. sp. (figs 27–29, 32, 33, 37–39)

Material examined: Holotype ♂, Saudi Arabia: Abha, 15.VII.1981, A. S. Talhouk, NHMB. Paratypes. Saudi Arabia: 15 ♂, 16 ♀, same as holotype, NHMB, AST, DB; 1 ♂, same, 15.VIII.1981 (wrongly labelled?), AST; 4 ♂, 5 ♀, Al Haïr, 27.IV.1976, W. Wittmer, W. Büttiker, NHMB, DB; 1 ♀, Wadi Johan, Abha, 2150 m, 19.IV.1976, W. Wittmer, W. Büttiker, NHMB; 1 ♀, Village Qaraah, Khamis mt., 2000 m, 16.IV.1976, W. Wittmer, W. Büttiker, NHMB. Kenya: 16 ♂, 13 ♀, Mt. Elgon, 6,500', 19.VIII.1973, *Acacia abyssinica*, S. Collins, BMNH; 4 ♂, 9 ♀, Michatha Forest nr. Molo, ca. 8,000', 17.VII.1974, beaten from *Acacia* sp., D. Hollis; 15 ♂, 14 ♀, Marmanet FR, 5–15 km N Thompsons Falls, ca. 8,000', 16.VII.1974, beaten from *Acacia hockii*, D. Hollis, BMNH, DB; 11 ♂, 11 ♀, Mt. Londiani Forest, 57 km W Nakuru, ca. 8,500', 20.VII.1974, beaten from *Acacia lahai*, D. Hollis, BMNH; 15 ♂, 19 ♀, Tinderet Forest, 5 km along Lessons rd., ca. 8,000', 20.VII.1974, beaten from *Acacia* sp., D. Hollis; 1 ♂, same, beaten from *Doryalis abyssinica*; 1 ♂, Nairobi Arboretum, ca. 5,400', 25.–26.VII.1974, beaten from *Albizia gummifera*, D. Hollis, same. Tanzania: 1 ♂, Kilimandjaro, SE slope, «Bismarck-Hügel», 2600–2800 m, III.–IV.1912, alpine meadows, St. 70, C. Alluaud & R. Jeannel, MNHN.

Description: Adult. Coloration. Head dorsally orange to brown, with whitish pattern; genal processes and clypeus white. Antennal segments 1–3 ochreous, 4–8 basally ochreous, apically dark brown, segments 9 and 10 dark brown. Thorax dorsally orange to brown with white pattern, forming longitudinal stripes on mesopraescutum and mesoscutum. Thorax laterally orange with white and

brown pattern, ventrally dark brown. Legs ochreous, femora and tarsi partially brown, metacoxae brown with white meracanthus. Forewings transparent to whitish, with dark pattern consisting of a broad band in the distal part of the wing, leaving free semicircular patches along the wing margin (fig. 27); veins ochreous, apices of veins dark brown. Hindwings transparent to whitish. Abdomen brown to dark brown. Male terminalia with orange proctiger and ochreous to brown parameres and subgenital plate.

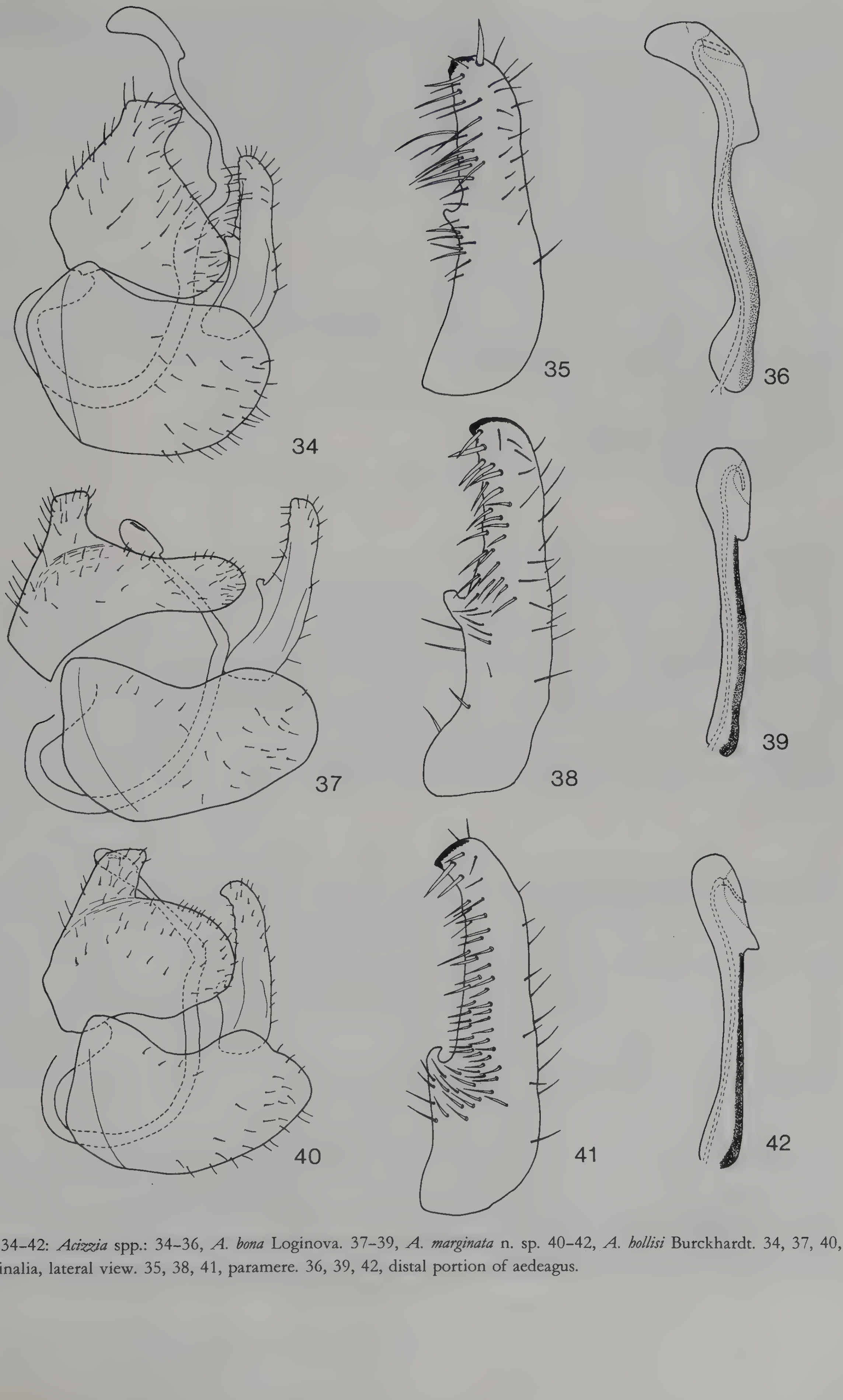
Structure. Head from above (fig. 28) wider than pronotum, about as wide as mesoscutum, hind margin somewhat concave; inclined, in profile, at about 20–45° to longitudinal axis of body. Vertex trapezoidal, with indented foveae; lateral ocelli on raised humps; median suture incised in front; median ocellus visible from above. Genal processes conical, 0.4–0.6 times longer than vertex along mid-line, lying in a plane lower and more inclined than vertex. Antennae 10-segmented, 1.7–2.1 times longer than head width, with a single subapical rhinarium on segments 4, 6, 8 and 9; relative length of flagellar segments from base to apex – 1.0 : 0.7 : 0.6 : 0.7 : 0.8 : 0.7 : 0.3 : 0.3; flagellar segments with a few setae shorter than width of segments; segment 10 with a pair of subequal, medium long terminal setae. Clypeus pyriform; apical 2 labial segments 0.3–0.5 times longer than head width. Thorax dorsally gently arched; propleurites (fig. 29) narrow, with both dorsal branches of median suture developed. Legs moderately robust. Meracanthus of metacoxae long spur-shaped. Metatibiae 0.7–0.9 times longer than head width, with a small basal spine, and 4–6 grouped apical spurs (1–2 inner, 2 anterior, 2 outer). Basal metatarsi with 2 black spurs. Forewings (fig. 27) oblong oval, in males 2.8–3.1 times and in females 3.1–3.4 times longer than head width, 2.2–2.6 times longer than wide; costal break present, sometimes indistinct; pterostigma relatively narrow. Cell cu1a 1.0–1.4 times wider than high. Hindwings somewhat shorter than forewings; with vein Cu1 usually branching off vein R+M+Cu1 first, basally indistinct; costal setae grouped. Terminalia as in figs 32, 33, 37–39. Male proctiger 0.3–0.4 times longer than head width, laterally produced in narrow, relatively long lobes, covered with medium long setae. Male subgenital plate long; dorsal margin in the middle strongly indented. Parameres lamellar, longer than proctiger, in the middle of the fore-margin with an upwards directed hook; inner surface bearing in the apical half along the fore-margin densely spaced long thick setae, along the hind-margin a few long thin setae. Proximal portion of aedeagus apically straight; distal portion straight with a short and relatively broad apical dilatation, as long or slightly shorter than proctiger; sclerotized end tube of ductus ejaculatorius straight. Female proctiger 0.8–0.9 times longer than head width, 3.0–5.1 times longer than circumanal ring; dorsal margin almost straight, in the middle weakly humped; apically blunt. Circumanal ring consisting of two rows of unequal pores. Female subgenital plate 0.6–0.7 times longer than proctiger, apically pointed. Valvulae 1 apically blunt, valvulae 2 cuneate, slightly curved, with a subapical indention on the dorsal side.

Measurements (7 ♂, 7 ♀). Head width 0.59–0.71 mm; antennae length 1.08–1.41 mm; proctiger length ♂ 0.19–0.22 mm, ♀ 0.52–0.61 mm; paramere length 0.23–0.26 mm; length of distal portion of aedeagus 0.16–0.20 mm.

Larva unknown.

Host plants: Adults were collected from *Acacia abyssinica* Hochst. ex Benth., *A. hockii* De Wild., *A. lahai* Steud. & Hochst. ex Benth., *A.* sp., *Albizia gummifera* (J. F. Gmel.) C. A. Sm. (Leguminosae) and *Doryalis abyssinica* Warb. in Engl. & Prantl (Flacourtiaceae); the latter, however, is unlikely to be a host.

Affinities: *Acizzia bona* Loginova and *A. hollisi* Burckhardt possess hooked parameres similar to *A. marginata*; the three are separated by characters given in tab. 1. They possibly form, together with *Psylla bicolorata* Samy and *Acizzia wittmeri* Burckhardt, a monophyletic group within the large old world genus *Acizzia*. *Psylla bicolorata* resembles *A. bona* in the male proctiger and the distal portion of the




Figs 34–42: *Acizzia* spp.: 34–36, *A. bona* Loginova. 37–39, *A. marginata* n. sp. 40–42, *A. hollisi* Burckhardt. 34, 37, 40, ♂ terminalia, lateral view. 35, 38, 41, paramere. 36, 39, 42, distal portion of aedeagus.

aedeagus, but differs in the shape of the parameres, the pattern of the forewings and the distribution of the surface spinules. *A. marginata* seems to be the sister species of *A. hollisi* differing mainly in the male terminalia. The female terminalia of the two species show no constant differences.

Comment: The original description of *A. hollisi* mentions a series of aberrant specimens (Burckhardt 1981). At the time, no nomenclatorial status was given to them due to the lack of sufficient material. This series belongs to *A. marginata*.

***Acizzia hollisi*** Burckhardt, 1981 (figs 40–42)

*Acizzia hollisi* Burckhardt, 1981: 216.

Distribution: Recorded from Palestine and Saudi Arabia (Burckhardt 1981, Halperin et al. 1982).

Host plant: *Acacia tortilis* (Forsskål) Hayne ssp. *raddiana* (Savi) Brenan, perhaps also ssp. *spirocarpa* (Hochst. ex A. Rich.) Brenan (Leguminosae).

***Acizzia wittmeri*** Burckhardt, 1981

*Acizzia wittmeri* Burckhardt, 1981: 219.

Distribution: Reported from Saudi Arabia (Burckhardt 1981).

Host plant unknown.

***Cacopsylla (Thamnopsylla) talhouki*** n. sp. (figs 43–50)

Material examined: Holotype ♂, Saudi Arabia: Abha, 15.VII.1981, A. S. Talhouk, NHMB. Paratypes. Saudi Arabia: 2 ♀, same as holotype, AST, DB.

Description: Adult. Coloration. Head brown with fine white pattern on vertex; genal processes basally whitish to yellow, apically dark brown. Antennal segment 1 brown, 2 yellow, 3 and 5 ochreous, 4, 6–8 ochreous with dark brown apices, 9 and 10 dark brown. Clypeus dark brown. Thorax dark brown, dorsally with fine white pattern. Legs brown, tarsi and partially also tibiae ochreous, metacoxae light brown. Forewings transparent with brown marginal band; veins ochreous, fore margin and pterostigma yellow. Hindwings transparent. Abdomen including terminalia dark brown. Teneral specimens yellow, with orange pattern on thorax. Coloration of antennae and forewings like in mature specimens.

Structure. Similar to *C. incerta* (Bajeva) and *suturalis* (Horvath) (Loginova 1975). Head from above (fig. 43) wider than pronotum, slightly wider than mesoscutum, hind-margin concave; in profile inclined at about 45° to longitudinal axis of body. Genal processes conical, apically blunt, sparsely covered with setae; 0.5–0.6 times longer than vertex along mid-line. Antennae 1.1 times longer than head width, with some setae slightly longer than width of flagellar segments; with a single subapical rhinarium on segments 4, 6, 8 and 9; segment 10 with a long pointed and a medium long truncated terminal seta; relative length of flagellar segments from base to apex – 1.0 : 0.8 : 0.7 : 0.6 : 0.7 : 0.8 : 0.4 : 0.4. Clypeus pyriform. Apical 2 labial segments 0.4–0.5 times longer than head width. Propleurites narrow, with both dorsal branches of suture developed (fig. 50). Metatibiae 0.6 times longer than head width, with small basal spine, and with 5 grouped apical spurs (1 inner, 3 anterior, 1 outer). Forewings (fig. 44) oval, 2.8 times longer than head width, 2.3–2.4 times longer than wide; costal break present; pterostigma basally broad, regularly tapering; branches of veins M and Cu1 relatively long. Membrane without surface spinules apart from cell cu2 and radular spinules in cells rs, m1+2, m3+4 and cu1a. Hindwings slightly shorter than forewings, membranous; costal setae grouped; vein R+M+Cu1 branching in R and M+Cu1. Terminalia as in figs 45–49. Male proctiger 0.4 times longer than head width, slim, tubular, in the apical two thirds evenly haired. Male subgenital plate short.

**Table 1. Caracters separating *Acizzia bona, marginata* and *hollisi.***

| | *bona* | *marginata* | *hollisi* |
|---|---|---|---|
| Pattern of forewings. | Apically indistinct brown with darker spots. | Well defined brown submarginal band. | Indistinct brown submarginal band. |
| Surface spinules of forewings. | Present in all cells, forming rings, leaving free stripes along the veins. | Present in all cells irregularly spaced, leaving broad free stripes along the veins. | Present in cell cu2 and in apical parts of wing. |
| Lateral lobes on male proctiger. | Broad. | Narrow. | Broad. |
| Hook on parameres. | Medially. | Medially. | In basal third. |
| Apical part of proximal portion of aedeagus. | Strongly curved backwards. | Straight. | Weakly bent backwards. |
| Apical dilatation of distal portion of aedeagus. | Long slender and slightly curved. | Short and thick, straight. | Medium long and moderately thick, straight. |
| Female proctiger. | Less than 0.7 times head width. | More than 0.8 times head width. | More than 0.8 times head width. |
| Male terminalia. | Figs 34–36. | Figs 37–39. | Figs 40–42. |
| Female terminalia. | Figs 30, 31. | Figs 32, 33. | As *marginata*. |

Parameres longer than proctiger, apically dilated and with a strongly sclerotized, forward directed hook; inner surface covered with medium sized robust setae. Distal portion of aedeagus apically dilated and curved. Sclerotized end tube of ductus ejaculatorius short, sinuous. Female proctiger 0.9 times longer than head width, 3.4 times longer than circumanal ring; dorsal margin distal to the circumanal ring somewhat indented, slightly turned upwards at apex; subgenital plate 0.5 times longer than proctiger. Valvulae 1 and 2 curved.

Measurements (1 ♂, 1 ♀). Head width 0.63–0.69 mm; antennae length 0.70–0.74 mm; forewing length 1.72–1.93 mm; proctiger length ♂ 0.26 mm, ♀ 0.64 mm; paramere length 0.34 mm; length of distal portion of aedeagus 0.24 mm.

Larva and host plant unknown.

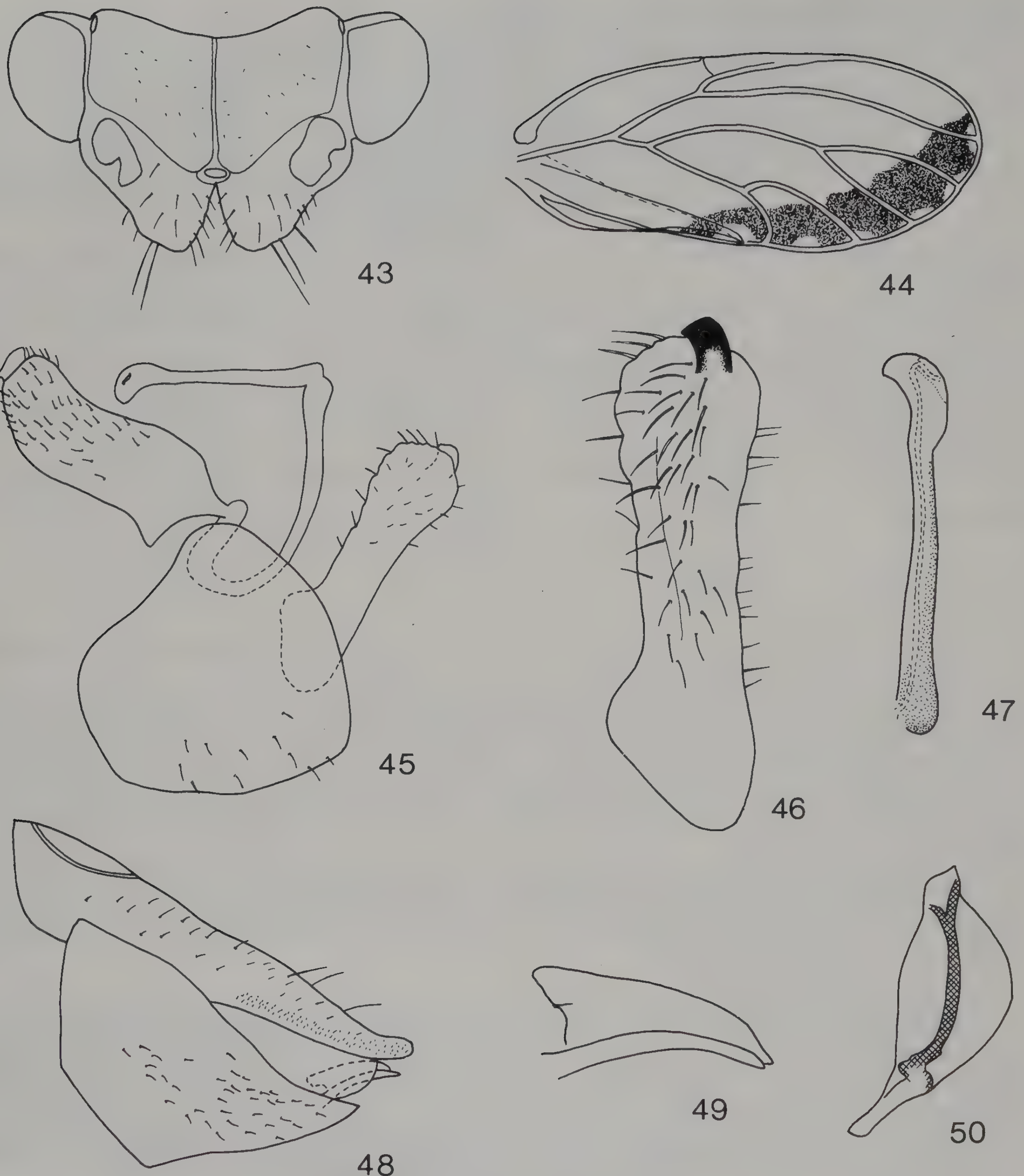
Affinities: *C. talhouki* is member of a species-complex feeding on *Rhamnus* and *Cerasus* spp. as defined by Loginova (1975), and is closest to *C. suturalis* and *incerta.* It can be separated from the former by the lack of surface spinules in the apical part of the forewings and the slightly thicker apex of the distal portion of the aedeagus; from the latter by the slimmer and less curved apex of the distal portion of the aedeagus and the upturned apex of the female proctiger. From both species it differs in the strongly widened apical third of the parameres and the genal processes which are more blunt.

## Fam. **Triozidae**

***Pauropsylla willcocksi*** Dçbsky, 1918

*Pauropsylla willcocksi* Dçbsky, 1918: 14.

Distribution: Recorded from the Cape Verde Is., Egypt, Saudi Arabia, Senegal and the Sudan (Hollis 1984). Material examined: Saudi Arabia: 11 ♂, 25 ♀, 90 larvae, Jizan, 18.III.1981, ex *Ficus* leaf galls, A. S. Talhouk, AST, DB; 4 ♂, 5 ♀, 21 larvae, same, 16.II.1981, *Ficus ?pseudo-sycomorus/sycomorus.*




Figs 43–50: *Cacopsylla talhouki* n. sp.: 43, head, dorsal view. 44, forewing. 45, ♂ terminalia, lateral view. 46, paramere. 47, distal portion of aedaegus. 48, ♀ terminalia, lateral view. 49, valvulae 1 and 2. 50, propleurite.

Host plants: *Ficus sycomorus* L., *F. gnaphalocarpa* A. Rich, *F. ?pseudo-sycomorus* Decaisne (Moraceae). The larvae form pit-galls on the leaves.

***Trioza buxtoni*** Laing, 1924

*Trioza buxtoni* Laing, 1924: 247.

Distribution: Recorded from Palestine (Halperin et al. 1982, Laing 1924). Material examined:

Saudi Arabia: 6 ♂, 1 ♀, 2 larvae, Abha, Jawsan, 3.II.1981, ex acorn galls on *Ficus carica*, A. S. Talhouk, AST, DB; 2 ♂, 4 ♀, 1 larva, Bisha, 3.III.1981, ex pocket galls on *Ficus ?exasperata*, A. S. Talhouk, AST, DB.

Host plants: *Ficus carica* L., *F. pseudo-sycomorus* Decaisne, *F. ?exasperata* Vahl. (Moraceae). The larvae live in pit-galls on the underside of the leaves.

***Trioza erytreae*** (del Guercio, 1918)

*Aleurodes erytreae* del Guercio, 1918. 167.

*Trioza erytreae* (del Guercio); Hollis 1984: 36.

Distribution: Recorded from Angola, Cameroun, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Reunion, Ruanda, Sao Tome, South Africa, St Helena, Sudan, Tanzania, Uganda, Zaire, Zimbabwe (Commonwealth Institute of Entomology 1967, Hollis 1984) and Saudi Arabia (Burckhardt 1981, Martin 1972).

Host plants: *Citrus* ssp., *Clausena anisata* (Willd.) Oliv., *Fagara capensis* Thunb., *Vepris undulata* (Thunb.) Verdoorn & C. A. Smith (Rutaceae). The larvae produce pit-galls on the underside of the leaves.

***Trioza lienhardi*** Burckhardt, 1981

*Trioza lienhardi* Burckhardt, 1981: 225.

Distribution: Recorded from Saudi Arabia and Tunisia by Burckhardt (1981).

Host plant: *Lycium* sp. (Solanaceae).

Three further undescribed species are listed but not formally described, as no males are available, which usually bear the taxonomically relevant characters:

***Colposcenia*** sp.

Material examined: Saudi Arabia: 1 ♀, W. Muraum, 12.,13.I.1984, W. Büttiker, NHMB.

Host plant unknown.

Comment: Closest to *C. elegans* (Bergevin), the species differs from other *Colposcenia* spp. by the partially strongly raised veins of the forewings and the long branches of vein M.

***Acizzia*** sp. 1

*Acizzia* sp.; Burckhardt, 1981: 223.

Distribution: Recorded from a single ♀ from Saudi Arabia (Burckhardt 1981).

Host plant unknown.

***Acizzia*** sp. 2

Material examined: Saudi Arabia: 1 ♀, Juayfiniyan, 960 m, 26.IV.1981, W. Büttiker, NHMB.

Host plant unknown.

Comment: The species is similar to *A. bona*, but has shorter and apically more rounded forewings, whose whole membrane is sparsely covered with brown spots.

## ACKNOWLEDGEMENTS

I thank Prof. Dr. A. S. Talhouk, Riyadh, Prof. W. Büttiker, Jeddah, Dr. M. Brancucci, Basel and Mr. D. Hollis, London for the loan of material. The latter and Dr. I. D. Hodkinson, Liverpool provided valuable discussions and comments on earlier drafts of the manuscript. I also thank Drs I. M. White, London and I. D. Hodkinson for the use of unpublished information. Miss A. Calverley, Rochdale kindly corrected my English.

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# Coleoptera: Fam. Buprestidae of Saudi Arabia (Part 4)

**S. Bílý**

Abstract: Ten species of Buprestidae (44 specimens) from the Eastern Province of Saudi Arabia are reviewed. One new species (*Acmaeoderella volkovitshi* n. sp.) is described, four species are new records for Saudi Arabia. Previously unknown males of *Xantheremia pantherina* (Bílý) and *Sphenoptera kermanshahensis* Obnb. are described.

Keywords: Coleoptera, Buprestidae, taxonomy, zoogeography.

غمديـات الأجنحة : عـائلة Buprestidae في المملكة العربية السعودية

( الجزء الرابع )

س . بيلي

خلاصة : تم مراجعة عشرة أنواع من عـائلة Buprestidae لدى دراسة ٤٤ عينة جمعت من المنطقة الشرقية من المملكة العربية السعودية . ولقد تم وصف نوع جديد (Acmaeoderella volkovitshi n. sp.) لأول مرة . كذلك سجلت ٤ أنواع جديدة للمملكة العربية السعودية وبالاضافة الى ذلك ، تم وصف ذكور (Xantheremia pantherina (Bílý و Sphenoptera kermanshahensis Obnb. الذين لم يسبق معرفتهم من قبل .

This paper continues the series (Bílý 1979, 1980, 1982) dealing with Buprestidae of Saudi Arabia and is based on the material collected by D. A. Pitcher in the Eastern Province. The material is deposited in the Manchester Museum and comprises 44 specimens of 10 species.

## Subfam. **Julodinae**

***Julodis caillaudi*** (Latreille, 1823)

*Buprestis caillaudi* Latreille, 1823. – Voy. à Meroë par Caillaud *4:* 277.

Saudi Arabia, Eastern Province, D.A. Pitcher, Ain Dar, 21 km N, X.1974 and II.1975, 8 exs.

Distribution: Senegal, Gambia, Algeria, Tunis, Lybia, Egypt, Sudan, Arabia, Ethiopia, Iran.

***Julodis speculifera*** Castelnau & Gory, 1835

*Julodis speculifera* Castelnau & Gory, 1835. – Silb. Rev. Ent. *2:* 160.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Udhailiyah Camp, 27.IV.1982, No. 164, 2 exs; Itawiyah, 8.IV.1983, No. 311, 1 ex.; Saltmine, Abqaiq, V.1975, 2 exs; Ain Dar, 7 km S, 30.IV.1982, No. 179, 2 exs.

Distribution: Arabia, Iraq, Iran, Syria, Eastern Turkey.

***Julodis euphratica*** Castelnau & Gory, 1837

*Julodis euphratica* Castelnau & Gory, 1837. – Monogr. Bupr. *1:* 18.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Udhailiyah Camp, 27.IV.1982, No. 164, 2 exs; Tawa Dukha, 28.V.1982, No. 193, 2 exs; Mishash, Udhailiyah Camp, 29.IV.1982, No. 173, 1 ex.

Distribution: Arabia, Sinai, Iraq, Iran, Afghanistan, Syria.

## Subfam. **Acmaeoderinae**

***Acmaeoderella*** (s. str.) ***volkovitshi*** n. sp.

Material: Holotype (♂) – Saudi Arabia, Eastern Province, D.A. Pitcher, Hawiyah, 21.IV.1983, No. 315; deposited in the Manchester Museum.

Slender and vaulted, elongate, black-bronze species; elytra black-brown with yellow longitudinal stripes; whole body with wide, lancet-shaped scales covering completely entire ventral side of body.

Head broad, slightly vaulted without medial groove, lateral margins of frons almost straight, diverging vertically; vertex 2.0 times as wide as width of eye and 1.14 times as wide as width of frons between antennal insertions; structure of head consisting of a network of shallow, umbilicate punctures with slight central grains; entire head completely covered with dense, lancet-shaped scales; antennae 1.87 times as long as vertical diameter of eye, enlarged from the 5th segment, with transverse distal segments.

Pronotum rounded, very slightly transverse, at the base 1.42 times as wide as long; lateral pronotal margins regularly rounded, maximum pronotal width in the middle; posterior pronotal margin straight, anterior margin with very slight medial lobe; lateral pronotal depressions simple, pit-shaped, praescutellar depression indistinct, medial longitudinal groove very feeble; lateral pronotal margins without keel; pronotal structure consisting of shallow cells without central grains; lateral parts of pronotum completely covered with wide, lancet-shaped scales, disc of pronotum with somewhat narrower, sparse scales.

Elytra prolonged, 2.35 as long as wide at humeral part, narrowed behind humeral swellings and enlarged at posterior third; epipleural subhumeral notch deep; apical part of elytra narrowly rounded, almost smooth only with very indistinct serration; elytral grooves consisting of large, rounded punctures which are somewhat deeper in posterior third; interstices somewhat vaulted, odd interstices (namely the 3rd one) broader than even ones; the 9th interstice elevated but smooth; structure of elytral interstices consisting of very small, indistinct punctures on the finely wrinkled basis; elytral scales forming compact rows; elytral pattern (fig. 1) very similar to that of *A. plavilscikovi* Obnb. and related species.

Legs black-bronze; first two tarsal segments completely without tufts of hairs; claws thin with a small, rectangular tooth.

Abdomen black-bronze with sparse umbilicate and simple punctures but completely covered with wide, lancet-shaped scales; anal sternite of male narrowly rounded apically.

Parameres obtuse apically, basal part wide and only slightly narrowed apically (fig. 3); aedeagal sides subparallel with wide laminae (fig. 2).

Length of body: 5.3 mm; width: 1.7 mm; female and bionomy unknown.

This species is named after my friend Dr. M.G. Volkovitsh, Leningrad, a well known specialist of Acmaeoderinae.

*A. volkovitshi* n. sp. is very closely related to the turanian species *A. plavilscikovi* Obnb. differing from it by the following characters:

| *A. plavilscikovi* Obnb.: | *A. volkovitshi* n. sp.: |
|---|---|
| Frons with medial groove or depression. | Frons slightly vaulted without groove. |
| Claws with acute tooth. | Claws with rectangular tooth. |
| Vertex 1.50–1.89 times as wide as width of eye. | Vertex 2.0 times as wide as width of eye. |
| Parameres sharp apically. | Parameres obtuse apically. |
| Basal part of tegmen narrow, whole aedeagus very narrowed posteriorly. | Basal part of tegmen broad, whole aedeagus subcylindrical. |
| Lamina of aedeagus slightly narrowed posteriorly. | Lamina of aedeagus slightly enlarged posteriorly. |

The male genitalia of *A. volkovitshi* n. sp. also resemble those of *A. turana* (Reitter) but the two species differ in the following characters:

| *A. turana* (Reitter): | *A. volkovitshi* n. sp.: |
|---|---|
| Frons with medial depression. | Frons vaulted. |
| Pronotum with well developed medial groove and laterobasal depressions. | Pronotum with indistinct medial groove and small, pit-shaped laterobasal depressions. |
| Lateral parts of pronotum with dense scales not completely covering the pronotal structure. | Lateral parts of pronotum with very dense scales covering completely the pronotal structure. |

***Xantheremia pantherina*** (Bílý, 1979)

*Acmaeodera pantherina* Bílý, 1979. – Fauna of Saudi Arabia *1:* 218.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Udhailiyah Camp, 27.IV.1982, No. 164, 4 exs.

Described from one female (Wadi Mizbil) (Bílý 1979;) further female found in Umm ad Dabah (Bílý 1982).

Male differs from female by slender body and somewhat smaller size. Species rather resembling (according to from of male genitalia, figs 4 and 5) *X. philistina* (Marseul) but copulatory aparati of both species differ in the following characters:

| *X. philistina* (Marseul): | *X. pantherina* (Bílý): |
|---|---|
| Apical part of parameres rounded laterally. | Apical part of parameres slightly incurved laterally. |
| Laminae of aedeagus very small and transverse. | Laminae of aedeagus relatively large, prolonged. |
| Apical margin of ovipositor rounded, almost naked, a few bristles condensed into groups. | Apical margin of ovipositor angulate, regularly covered with setae. |

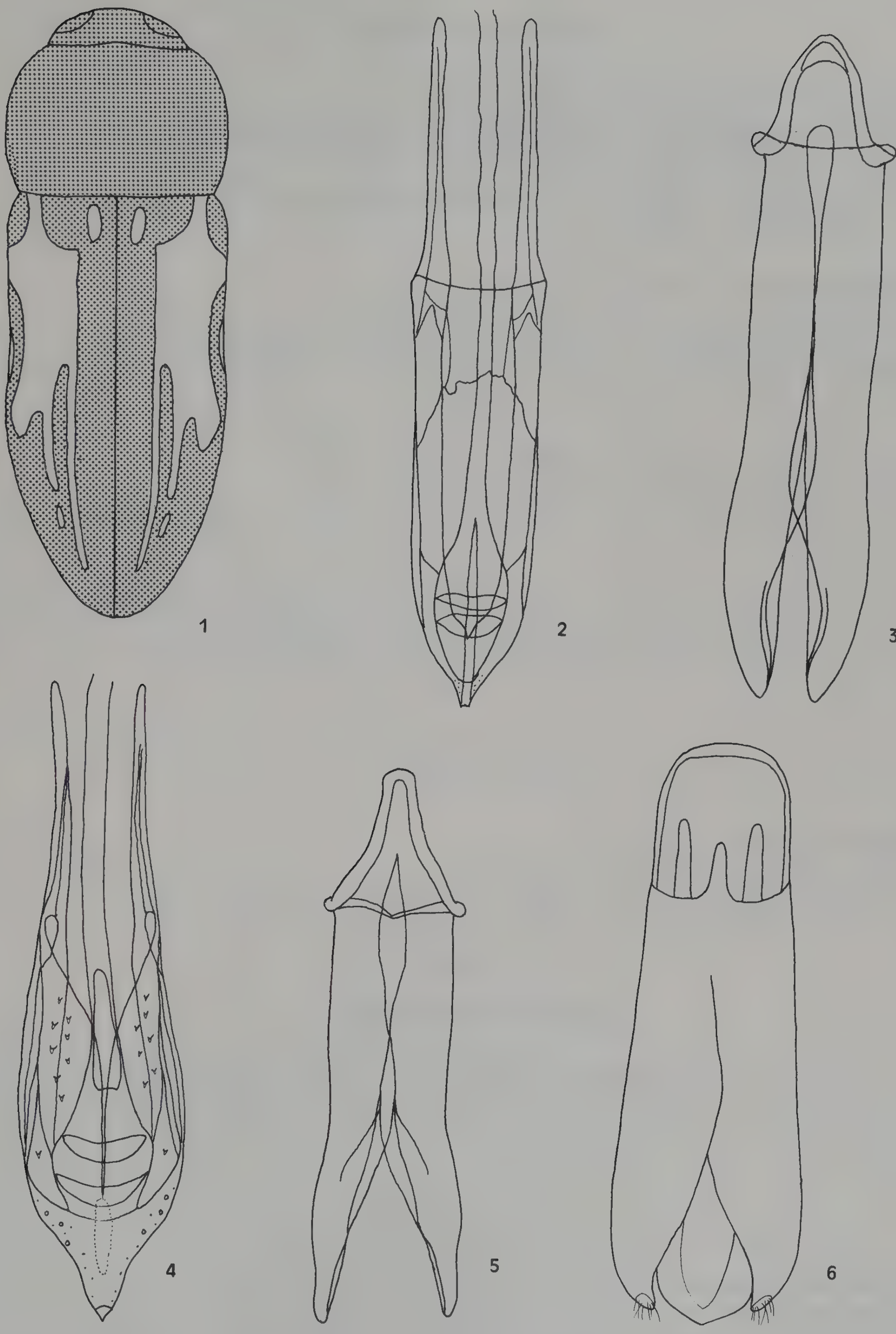
## Subfam. **Buprestinae**

***Capnodis excisa*** Ménétries, 1848

*Capnodis excisa* Ménétries, 1848. – Mém. Acad. Petersb. *4:* 44.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Ain Dar, 8.5 km N, IX. 1974, 4 exs; Abqaiq, 11 km NE, I.1975, 2 exs.

Distribution: Transcaspia, Central Asia, Afghanistan, Iraq, Iran; new record for Saudi Arabia.




Figs 1-6: 1, *Acmaeoderella* (s. str.) *volkovitshi* n. sp., body shape and elytral pattern, holotype, 5.3 mm; 2, the same, aedeagus; 3, the same, parameres; 4, *Xantheremia pantherina* (Bílý), aedeagus; 5, the same, parameres; 6, *Sphenoptera (Paradeudora) kermanshahensis* Obnb., male genitalia.

Subfam. **Sphenopterinae**

***Sphenoptera*** (s. str.) ***magna*** Castelnau & Gory, 1839

*Sphenoptera magna* Castelnau & Gory, 1839. – Monogr. Bupr. *2:* 3.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Shedgum, 30.IV.1982, No. 180, 4 exs.

Distribution: Arabia, E Turkey, Iraq.

***Shenoptera (Chrysoblema) dumonti*** Théry, 1922

*Sphenoptera dumonti* Théry, 1922. – Bull. Soc. Hist. Nat. Afrique Nord, *13:* 30.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Al Hasa, Aranco Fain, 19.XI.1981, 2 exs.

Distribution: Algeria, Tunis; new record for Saudi Arabia.

***Sphenoptera (Paradeudora) kermanshahensis*** Obenberger, 1948

*Sphenoptera kermanshahensis* Obenberger, 1948. – Acta ent. mus. nat. Pragae, *26:* 4.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Ain Dar, 8.5 km N, V.1975, 5 exs; Uqair, 19 km SE, V.1975, 1 ex. (♂).

Described by Obenberger (1948) from a single female from Kermanshah (SW Iran). Male differs from female by conspicuously bent protibiae and by slender and smaller body. Aedeagus (fig. 6) very short, robust and obtuse, parameres slightly enlarged apically with hooked apical tips. This species is probably distributed around the whole Arabian Gulf; new record for Saudi Arabia.

Subfam. **Trachyinae**

***Aphanisticus pygmaeus*** Lucas, 1849

*Aphanisticus pygmaeus* Lucas, 1849. – Expl. Alg. Ent.: 161.

Saudi Arabia, Eastern Prov., D.A. Pitcher, Al Uyun, Al Hasa, 15.X.1982, No. 238, 1 ex.

Distribution: Mediterranean, Transcaucasus, Turkey; new record for Saudi Arabia.

## ACKNOWLEDGEMENTS

I am very obliged to Dr. Colin Johnson, Manchester, for the opportunity of studying this interesting material and to Dr. M.G. Volkovitsh, Leningrad, for the differential diagnosis of the new species of *Acmaeoderella*.

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# Contribution to the Distribution of the Pterophoridae in Saudi Arabia

**E. Arenberger**

Abstract: Thirteen species of Pterophoridae are recorded from Saudi Arabia. *Agdistis hakimah* n. sp., *Arcoptilia* n. gen., *Arcoptilia gizan* n. sp. and *Pselnophorus lanceatus* n. sp. are described.

Keywords: Lepidoptera, Pterophoridae, taxonomy, faunistics.

توزيع حاملات الأجنحة (Pterophoridae) في المملكة العربية السعودية

ا. ارنبرغر

خلاصة : تم تسجيل ثلاثة عشر نوعا من حاملات الأجنحة في المملكة العربية السعودية . كذلك تم وصف جنس جديد Arcoptilia ونوعين جديدين Arcoptilia gizan n. sp. و Pselnophorus lanceatus n. sp. و Agdistis hakimah n. sp.

## INTRODUCTION

Over the past few years, several entomologists have concentrated their interests on the as yet poorly known insect fauna of the Arabian peninsula. In 1979, H. G. Amsel collected mainly in the Asir Mountains of Saudi Arabia and brought back a rich microlepidoptera material for scientific study. C. Holzschuh had the opportunity in 1983 to collect Coleoptera in Saudi Arabia. He also, however, collected a number of interesting pterophorids. Also included in the present paper is the plume material resulting from the collecting expeditions of Prof. W. Büttiker, Dr. W. Wittmer and U. S. Nielsen. I would like to thank all of these entomologists for making their material available for study. Particular gratitude belongs to Mr. S. E. Whitebread for translating the manuscript from German into English. As was to be expected, amongst the material were several representatives of the genus *Agdistis* whose species are commonly found in halophile and eremic localities. Especially gratifying is the fact that the material contained one undescribed species of this genus: *Agdistis hakimah* n. sp. Also amongst the material was an undescribed species of the subfamily Platyptiliinae for which it has been necessary to erect a new genus: *Arcoptilia* n. gen. *gizan* n. sp. The subfamily Pterophorinae was very sparsely represented, yet here also one species could be described: *Pselnophorus lanceatus* n. sp.

## RECORDS AND DESCRIPTIONS

1. ***Agdistis tamaricis*** (Zeller, 1847)

*Adactyla tamaricis* Zeller, 1847. – Isis von Oken (1847): 899.

Saudi Arabia: Qatif, sea-level, 14.–15.IV.1983, Holzschuh. – Saudi Arabia: Hofuf, 150 m, 12. – 13.IV.1983, Holzschuh.

2. ***Agdistis arabica*** Amsel, 1958

*Agdistis arabica* Amsel, 1958. – Beitr. naturk. Forschung SüdwDtl. *17:* 75.

Saudi Arabia: Hakimah, near Abu Arish, 140 m, 15.IV.1979, Amsel.

3. ***Agdistis bellissima*** Arenberger, 1975 fig. 2

*Agdistis bellissima* Arenberger, 1975. – Ent. Z. Frankfurt a.M. *85:* 113–114.

Saudi Arabia: Najran, 24.III.1983, Holzschuh.

4. ***Agdistis nanodes*** Meyrick, 1906 fig. 3

*Agdistis nanodes* Meyrick, 1906. – J. Bombay nat. Hist. Soc. *17:* 136.

Saudi Arabia: Qatif, sea-level, 14.–15.IV.1983, Holzschuh. – Saudi Arabia: Hakimah, near Abu Arish, 140 m, 15.IV.1979, Amsel.

5. ***Agdistis obstinata*** Meyrick, 1920 figs 4, 10, 11

*Agdistis obstinata* Meyrick, 1920. – Voyage Alluaud Afr. Orient.: 44.

Saudi Arabia: Asir Mts., 2000 m, Wadi Marah, 81 km S Biljurshi, 22.IV.1979, Amsel. – Saudi Arabia: Asir Mts., 2350 m, 5 km S Namas, 17.–21.IV.1979, Amsel. – Saudi Arabia: Asir Mts., 2450 m, 17.III.1980, Büttiker. – Saudi Arabia: Asir Mts., 2000 m, VIII.1979, 81 km S Biljurshi, Vogel.

6. ***Agdistis hakimah*** n.sp. figs 5, 12, 13

Holotype, ♂: Saudi Arabia: Hakimah, near Abu Arish, 140 m, 15.IV.1979, Amsel, LNK. – Paratypes: 1 ♂ 2 ♀, Same data as the holotype, LNK, Arenberger.

Description: Wing expanse 12 mm. Forewing grey-brown, with numerous scattered dark scales. Costal edge with four spots, increasingly more closely spaced distally. Three spots on the margin of the lower fold. Antennae ringed brown and white. Facial prominence weakly conical.

Genitalia, ♂: The two valves asymmetrical, both slightly curved inwards to the dorsal edge and rounded distally. Both valves with a short projection on the dorsal edge at ⅔, the left one dentate, lobe-like on the right. Costal arms of unequal length. The left is only about half the length of the right, but somewhat thicker. The tegumen consists of two struts. The base of the uncus as wide as the left costal arm. A narrow process projecting ventrally at an angle of about 45° from the uncus at ½. 8th sternite caudal with a U-shaped indentation forming two narrow prongs. Sacculus strongly developed, bulging over the base of the 8th sternite. Aedeagus weakly curved, widening a little at the tip.

Genitalia, ♀: The mouth of the ostium bordered by two weakly sclerotized, pointed processes. Antrum little sclerotized, widening slightly towards the ductus bursae. The latter wider than the antrum, leading into the corpus bursae at no definite point. The ductus seminalis leading from the oral end of the antrum. Apophyses posteriores bristle-like, not longer than the pappiles anales. The apophyses anteriores are two short pointed processes curved distally. Distal edge of the 7th sternite slightly convex.

Early stages and ecology: Unknown, adults IV.

7. ***Stenoptilia zophodactyla*** (Duponchel, 1838)

*Pterophorus zophodactylus* Duponchel, 1838.– Histoire Naturelle des Lépidoptères: 668.

Saudi Arabia: Fayfa (in the mountains near Gizan), 27.–31.III.1983, Holzschuh.

8. ***Mariana taprobanes*** (Felder & Rogenhofer, 1875)

*Amblyptilia taprobanes* Felder & Rogenhofer, 1875. – Reise Novara *2:* 54.

Saudi Arabia: Al Khardj, 16./17.IV.1978, Büttiker.

## *Arcoptilia* n. gen.

Type species: *Arcoptilia gizan* n. sp.

Description: Face prominent, weakly rounded, densely scaled, smooth. Labial palpi ascending, smooth, terminal segment ½ the length of the middle segment. Maxillary palpi absent. Antennae shortly ciliate.

Forewing: The cleft reaches to ⅓, termen of the first lobe oblique, tornus present, termen of second lobe concave. Vein $r_1$ absent, $r_2$ separate, $r_3$ stalked with $r_4$ and $m_3$ stalked with $cu_1$, $r_5$ separate.

Hindwing: First lobe with two veins, 2nd with three, $m_3$ stalked with $cu_1$ and third with one vein. Frenulum with one bristle.

Arcoptilia contains, as yet, only generic type, so a characterisation of the genitalia will be given in the description of the new species.

9. ***Arcoptilia gizan*** n. sp., figs 1, 6, 7, 14, 15

Holotype, ♂: Saudi Arabia, Hakimah, near Abu Arish, 140 m, 15.IV.1979, Amsel, LNK. – Paratypes: 5 ♂, 1 ♀, same data as the holotype, LNK, Arenberger. – 1 ♂, Saudi Arabia, Hakimah, 85 m, 14.–15.X.1975, Büttiker, NHMB. – 12 ♂, Saudi Arabia, Gizan, Red Sea, 25.–26.III.1983, Holzschuh, NHMB, Arenberger. – 1 ♂, Saudi Arabia, Fayfa, in the mountains near Gizan, 27.–31.III.1983, Holzschuh, NHMB. – 1 ♀, Ethiopia, Gaharre, Dancalia, XII.1928, Sped. Franchetti, INER.

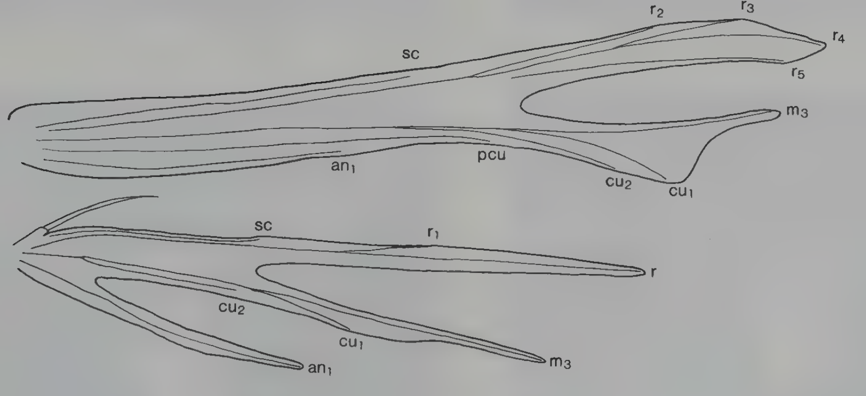



Fig. 1: *Arcoptilia gizan* n. sp., venation.

Fig. 2: *Agdistis bellissima* Arenberger.

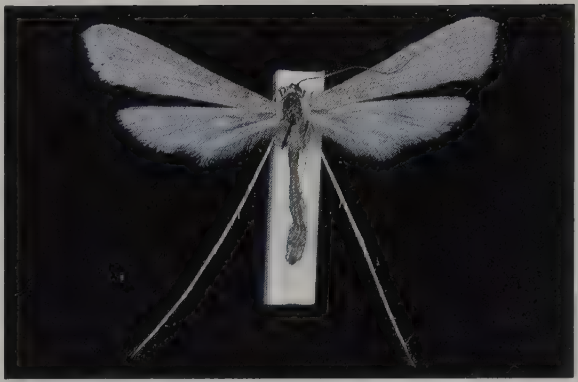


Fig. 3: *Agdistis nanodes* Meyrick.

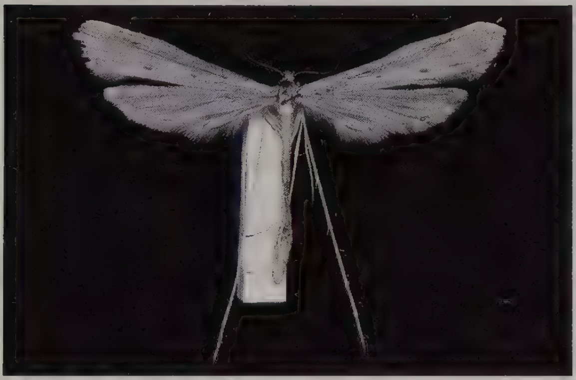


Fig. 4: *Agdistis obstinata* Meyrick.

Fig. 5: *Agdistis hakimah* n. sp.

Fig. 6: *Arcoptilia gizan* n. sp., ♂.

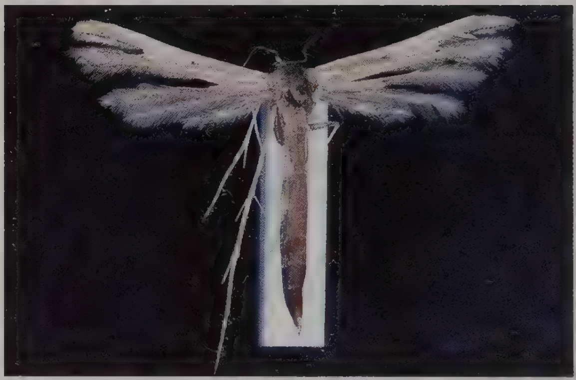


Fig. 7: *Arcoptilia gizan* n. sp., ♀.

Fig. 8: *Megalorhipida defectalis* Walker.

Fig. 9: *Pselnophorus lanceatus* n. sp.

Description: Wing expanse ♂ 15–17 mm, ♀ 20 mm. Fore- and hindwing of the male dark brown, roughly scaled. The femals are coffee-brown. Costal margin of forewing brown, above the base of the cleft a white spot, followed by a brown and a white spot, then brown to the apex. Forewing cleft to about ⅓, termen of the first lobe oblique, tornus present. Second lobe widest in the middle, termen concave, apex extended. Tornal cilia of the first lobe white, often mixed with brown scales. Costal cilia of the second lobe brown, white at base resulting in a more or less broad, white basal line. Scales brown at the apex. Terminal cilia whitish mixed with several brown scales.

In the forewing, vein $r_1$ absent, $r_2$ separate, $r_3$ stalked with $r_4$, $r_5$ separate, $m_3$ stalked with $cu_1$. The first lobe of the hindwing with 2 veins, 2nd lobe with 3, $m_3$ stalked with $cu_1$, 3rd lobe with one vein. Frenulum with one bristle. A scale-tooth distally on the 3rd lobe, the scales of which become shorter distally. Labial palpi brown, terminal segment ½ the length of the middle segment, smooth. Face prominent, weakly rounded. Antennae relatively short, only just ½ the length of the forewing, shortly ciliate. Hindlegs without scale thickening.

Genitalia, ♂: Valves trowel-shaped. End of left valve more pointed than that of the right, sacculus narrow, reaching to the middle of the valve. The anellus consisting of two hump-shaped lobes. The tegumen in the form of an arched brace. Aedeagus slightly curved, without cornutus. 8th sternite weakly indented distally.

Genitalia, ♀: Mouth of the ostium ringed by a few sclerotized bars. Ductus bursae very long and narrow, about the length of the apophyses posteriores. Corpus bursae bladder shaped, signum absent. Ductus seminalis leading from the ductus bursae close to the caudal end of the bursa. Apophyses anteriores absent. Caudal margin of the 7th sternite convex.

Early stages and ecology: Unknown. Adult III, IV, X, XII.

10. ***Stangeia siceliota*** (Zeller, 1847)

*Pterophorus siceliota* Zeller, 1847. – Isis von Oken (1847): 907.

Saudi Arabia: Asir Mts., 2350 m, 5 km S Namas, 17.–21.IV.1979, Amsel. – Saudi Arabia, Asir Mts., 2000 m, Wadi Marah, 29.4.–2.V.1979, 81 km S Biljurshi, Amsel.

11. ***Megalorhipida defectalis*** (Walker, 1864) fig. 8

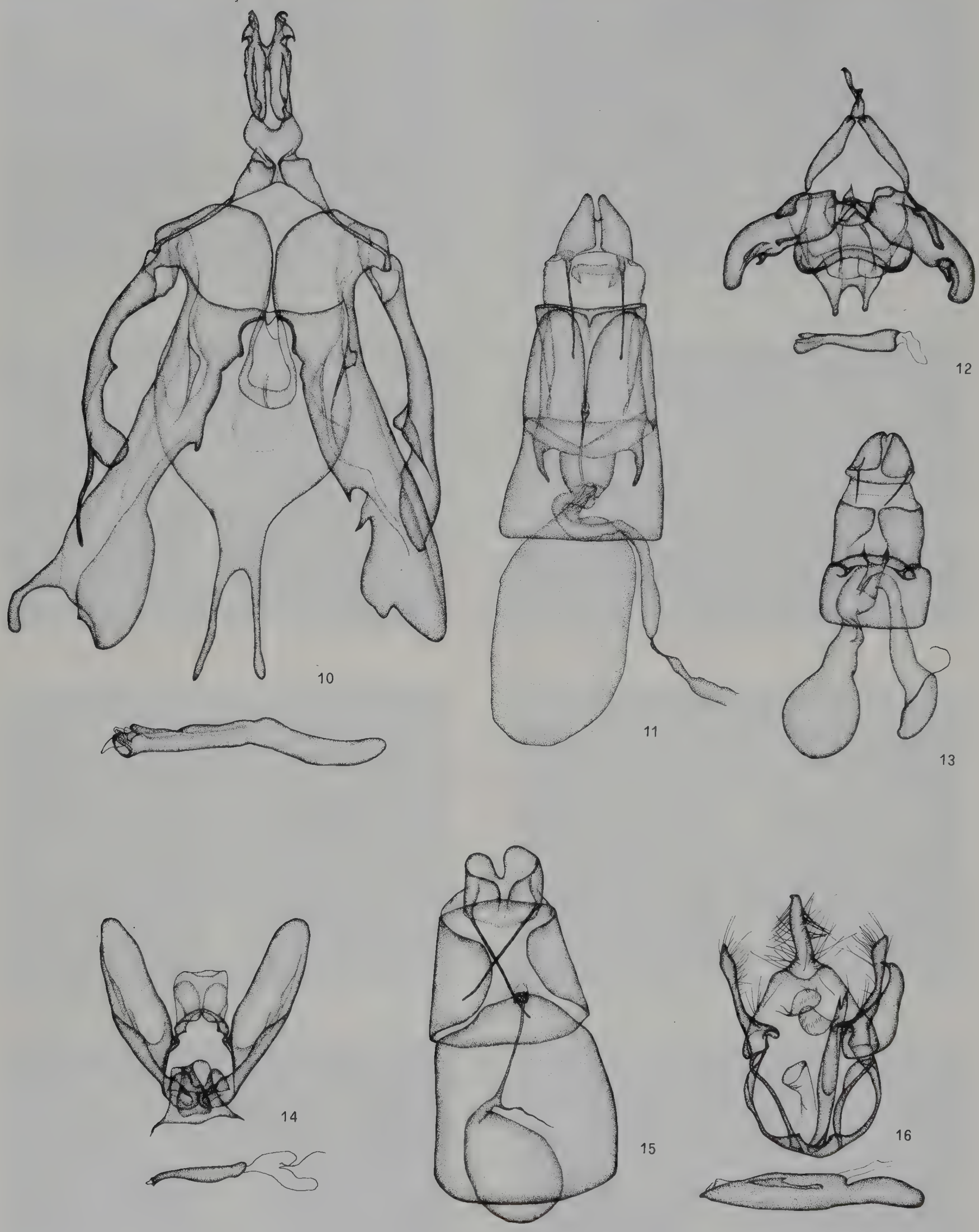
*Pterophorus defectalis* Walker, 1864. – List of the specimens of Lepidopterous Insects in the collection of the British Museum *30:* 943.

Saudi Arabia, II.1980, Djidda, Northern Creek, Nielsen. – Saudi Arabia, 25./26.IV.1977, Bahara, Büttiker. – Saudi Arabia, Fayfa, in the mountains near Gizan, 27. – 31.III.1983, Holzschuh. – Saudi Arabia, Wadi Maraba, 142 km from Jizan, 350 m, 13.IV.1979, Amsel. – Saudi Arabia, Asir Mts., 2000 m, 81 km S Biljurshi, Juni 1979, Vogel. – Saudi Arabia, Asir Mts., 2000 m, Wadi Marah, 29.IV.–2.V.1979, 81 km S Biljurshi, Amsel. – Saudi Arabia, W. Shuqub/Turabah, 1250 m, 21.IV.1980, Büttiker. – Saudi Arabia, 16 km W Badr Hundyn, 18.IV.1978.

12. ***Pselnophorus lanceatus*** n. sp. figs 9, 16

Holotype, ♂: Saudi Arabia, Fayfa, in the mountains near Gizan, 27.–31.III.1983, Holzschuh, NHMB. – Paratypes: 1 ♂, same data as the holotype, Arenberger. – 1 ♂, Saudi Arabia, Gizan, Red Sea, 25.–26.III.1983, Holzschuh, NHMB.

Description: Wing expanse 10 mm. Forewing cleft to more than ½, ground colour dirty white, weakly mixed with brown scales. A brown spot before middle of, and stretching right across, the first lobe, another just before the apex, not reaching the costa. A further brown spot in the middle of the




Figs 10–16: 10, *Agdistis obstinata* Meyrick, male genitalia; 11, *Agdistis obstinata* Meyrick, female genitalia; 12, *Agistis hakimah* n. sp., male genitalia; 13, *Agdistis hakimah* n. sp., female genitalia; 14, *Arcoptilia gizan* n. sp., male genitalia; 15, *Arcoptilia gizan* n. sp., female genitalia; 16, *Pselnophorus lanceatus* n. sp., male genitalia.

2nd lobe. Cilia white, only on the tip of the first lobe brown dorsally. Palpi very narrow, third segment shorter than the middle, pointed distally, weakly ascending. Antennae longer than ½ the length of the forewing.

Genitalia, ♂: Valves medially very narrow, widening distally. Right valve with a costal arm which at its base is about three times the width of the valve, but quickly becoming narrower distally, ending in a curved, thorn-like process. Uncus straight, stout, thicker than the valves, about the length of the tegumen. Anellus funnel shaped. A bicuspidate rod-like structure reaching from the vinculum to the middle of the tegumen. Aedeagus pointed, a single barbed cornutus.

Genitalia, ♀: Unknown.

Early stages and ecology: Unknown. Adult III.

13. ***Emmelina monodactyla*** (Linnaeus, 1758)

*Phalaena Alucita monodactyla* Linnaeus, 1758. – Systema Naturae ed. *10:* 542.

Saudi Arabia, 20.IV.1976, km 8–20 on Abha Taif road, 2100 m, Wittmer & Büttiker. – Saudi Arabia, Riyadh, 31.V.1979 Talhouk.

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# Lepidoptera: Rhopalocera of Western Saudi Arabia

**A.R. Pittaway**

Abstract: This paper is a field survey of the butterflies of western Saudi Arabia, with emphasis being placed on biology, ecology and seasonality. One new subspecies is described: *Zegris eupheme larseni* n. ssp., and there are numerous new distribution and foodplant records for Saudi Arabia.

Keywords: Lepidoptera, Rhopalocera, Western Saudi Arabia.

حرشفيات الأجنحة : Rhopalocera

فراشات غرب المملكة العربية السعودية

ا. ر. بيتاواي

خلاصة : تمثل هذه الدراسة مسح ميداني لفراشات غرب المملكة العربية السعودية ، كذلك يتطرق البحث بسرد تفاصيل بيولوجية وبيئية وموسمية هذه الأنواع . وتم أيضا وصف تحت النوع Zegris eupheme larseni n. ssp. لأول مرة .

## CONTENTS

# INTRODUCTION

Saudi Arabia, and the rest of the Arabian Peninsula, has the dubious distinction of being the only landmass where three biogeographical zones merge – the Palaearctic, Oriental and Ethiopian. Past fluctuations in climate have produced a butterfly fauna drawn from all three zones, plus some specially adapted to the transition zone itself (eremic). Generally speaking, there is a decline in Ethiopian and Oriental elements from south to north, with the reverse being true for Palaearctic species. From west to east, especially along the peninsula's southern half, Ethiopian butterflies predominate although they decline in terms of both numbers and species towards the Gulf. In the opposite direction certain Oriental butterflies have managed to penetrate, but their numbers are few. Unfortunately, topographical variations have altered this scheme somewhat and one finds Palaearctic communities penetrating deep into otherwise tropical zones on mountain ridges.

The history of collecting butterflies in Saudi Arabia has been amply covered by Larsen (1983). It is sufficient to say that the information for this paper was obtained in 1977/78 and between July 1982 and July 1984 (when the author was resident in Jeddah) and compliments other data on Saudi Arabia (Pittaway 1979a, 1979b, 1981), on Qatar (Pittaway 1980) and on Oman and Kuwait (in Larsen 1983).

## Topography

The area in question, from the Yemen border near Jizan (see fig. 1), up past Jeddah and Yanbu to the northerly Jordan border near Haql and inland as far as Hail and Buraydah, consists of three topographical zones. The low-lying coastal strip, or Tihama ("the hot place"), consisting of silt deposits and wind-blown sand interspersed with lava flows, fringes the entire length of the Red Sea.

Between 100 and 200 km inland, running parallel to this sea, is a mountain range known as the Asir (south of Taif) or Hejaz (north of Taif). The Asir highlands form a precipitous, west facing escarpment (see fig. 1) with steep sided gorges draining towards the Red Sea through a series of minor foothills. Peaks on this impressive escarpment soar to just over 3000 m near Abha (Jebel Suda = Soodah) and to between 2000 and 2700 m around Taif. North of here there is no escarpment and the Hejaz mountains comprise a jumble of rocky valleys and fragmented stony slopes which rarely exceed 1500 m altitude; Jebel Radhwa near Yanbu (Yenbo, Jenbo) is an exception at 1800 m. However, approximately 150 km due south of Haql these fragmented hills come together once again in two parallel ridges wich rise to over 2400 m (Jebel al Lawz). These continue NNE to link up with the highlands of eastern Jordan (see Larsen & Nakamura 1983).

From the Dead Sea in Jordan to North Yemen the highlands eastern slopes are far more gentle with long flood channels (wadis) draining through to an inland plateau. Most of this expanse is a mixture of sedimentary and, especially nearer the west, igneous rock. Between Haql and Hail there is also a large sand desert – the Great Nafud, and a similar one between Riyadh and An Nimaas – Nafud Dahi.

Entomologically speaking, two topographical formations are of great interest in this region. Running up from south of Riyadh to just east of Buraydah are the limestone hills of the Jebel Tuwayq (Tuwaiq), complete with a west facing escarpment. Further north, around Hail, lie the granite and porous crystalline rock ridges of the Jebel Shammar, of which the Jebel Aja are a part.

## Vegetation and ecology

For a full account of the vegetation of western Saudi Arabia one should refer to Vesey-Fitzgerald (1955, 1957a, 1957b), however, the following is a basic description of the communities encountered in this survey.


Fig. 1: Western Saudi Arabia, with the Asir escarpment shown as a toothed line.

By and large the vegetation of the flat Tihama was an *Acacia-Maerua* orchard with seasonal developments of perennials and annuals. *Acacia tortilis* predominated, along with *A. asak, A. mellifera* and *A. ehrenbergiana. Maerua crassifolia* also formed pure stands and, in silty depressions, an association with *Capparis decidua.* These communities extended the entire length of the coastal plain, although there was a gradual change in associate plants from south to north. Around Jizan *Commiphora* species tended to replace *Maerua* and, along the wadis, stands of *Delonix alata, Hyphaena thebaica, Dobera glabra* and *Moringa peregrina* were a marked feature. It was interesting to note that whereas *Dobera* died out north of Abha, *D. alata* reached Jeddah and *H. thebaica* was exceedingly rare or absent in a large stretch between Muhayil and Khayber (north of Yanbu). Beyond there it extended to Jordan.

The vegetation of the Hejaz and Asir foothills on the other hand, was not only influenced by latitude, but also by altitude and aspect and could be very complex. Inland from Jizan and north to Muhayil, between 200 and 500 m, succulents dominated flat ground inbetween stands of *Acacia ehrenbergiana* and *A. tortilis – Euphorbia triaculeata, E. cactus, Caralluma* sp., *Aloe officinalis, Sansevieria* sp. and *Adenium arabicum.* Along river courses these were supplemented by *Cissus rotundifolia, Salvadora persica* and *Zizyphus spina-christi.* With altitude many succulents disappeared, to be replaced by *Commiphora* sp. and *Euphorbia cuneata.* Between 500 and 1500 m *Acacia asak, A. etbaica* and other *Acacia* sp. gradually took over with *Commiphora* and *Grewia velutina.* Water channels, which eventually became wadis, supported

stands of *Ficus salicifolia, Z. spina-christi* and *Ficus sycamorus,* overgrown with *Cissus rotundifolia* and *Coccinia grandis* (Cucurbitaceae).

At 1500 m in the Feifa (Faifa) area there was a narrow band of xerophytic *Dracaena* trees, similar to *D. draco,* which proceeded no further north than Abha. (This was rather interesting as many other plants lower down on the Tihama, as well as certain butterflies, also stopped there. This could indicate some climatic change from the monsoon influenced vegetation further south, to a drier northern zone). Above 1500 m *Dodonaea viscosa* appeared as did *Olea chrysophylla; A. etbaica* became the dominant and, sometimes, the only *Acacia.* At 1800 m *Juniperus procera* made its appearance, although it only became dominant in higher areas, especially along the escarpment edge.

All these zones described continued north along the escarpment as far as Taif, as well as inland as far as precipitation permitted, thus, the *Juniperus* zone, with its associate plant community of *D. viscosa, Lavandula dentata, Euryops arabicus* and *Rosa abyssinica,* varied in width from 100 m to over 3 km in places. Here and there in very favourable localities at a slightly lower altitude, it ceeded dominance to *Olea* and *Pistacia palaestina tripartita,* with their associate *D. viscosa, Carissa edulis, Euclea schimperi, Buddleja polystachya, Clematis wightiana, Rhus* sp. and *Lotus arabicus.*

North of Taif the escarpment vegetation zones broke up and, far to the north, gave way to Irano-Turanian, or even Mediterranean, counterparts. Those mountains directly north of Jeddah/Taif generally did not exceed 1500 m and tended to be dotted with the dominant *A. asak,* with *Juniperus* only on isolated summits, e.g.: Jebel Radhwa. Below 800 m *A. asak* gave way to *A. mellifera, A. hamulosa* and, finally, *A. tortilis.* Sandy washes and wadis supported *Calotropis procera, Leptadenia pyrotechnica, Rhazya stricta, Aerva javanica* and *Dipterygium glaucum.* Many of these plants also followed wadis out onto the Tihama and, as a consequence, were to be found as far north as Haql.

North of Yanbu, directly inland from Wejh, the appearance of *Retama (=Lygos) raetam* and *Zilla spinosa* at 1000 m indicated both Irano-Turanian and Saharo-Sindian intrusions from the north and east. Inland from Haql both of these plants were exceedingly common in alluvial valleys above 800 m. At higher elevations (1500 m) *Ferula sinaica, Artemisia herbalba, Isatis lusitanica* and *Fagonia mollis,* with the occasional *Colutea istria* bush, supported the above biogeographical observations.

The Jebel Tuwayq and Jebel Shammar mountains further east also supported an essentially Irano-Turanian flora, although the species composition varied somewhat due to substrate differences. Tuwayq Hill wadis were characterised by *Teucrium oliverianum, Astragalus spinosus, Zilla spinosa, Anvillea garcini* and *Lycium persicum.* All, bar *T. oliverianum,* also occurred in the J. Shammar, which also supported *Isatis lusitanica* and some fine stands of *Pistacia atlantica* (both absent from the J. Tawayq). Whereas the mountains around Hail could have been considered an isolated pocket of the "eastern Jordanian Desert", the J. Tuwayq were essentially an extension of the "southern Jordanian Desert" with eastern intrusions (see Larsen & Nakamura 1983).

The surrounding plateau, up to the eastern slopes of the Hejaz and Asir mountains, was basically impoverrished *Acacia* parkland with isolated stands of *Lycium* and *Maerua.* However, the vegetation was very much Saharo-Sindian in character: very few butterflies inhabited this area.

## Rainfall

Again, Vesey-Fitzgerald (1955, 1957a, 1957b) covers this subject very adequately, but it should be said that although little rain falls over most of western Saudi Arabia (less than 100 mm per annum), certain areas do receive more, e.g. the J. Tuwayq, J. Shammar, Jebel al Lawz area near Haql and, especially, the high Asir, where it can exceed 300 mm. However, although it normally rains in the north between November and May and along the southern Asir during April and the August-October mon-

Plate 1: Typical gully in the Jebel al Lawz area (SE of Haql), with *Retama raetam* and *Ferula sinaica*. Both *Papilio saharae saharae* and *Euchloe aegyptiaca* occurred here.

soon, the amounts involved and their frequency can vary enormously from year to year. 1982/1983 was "normal" for western Saudi Arabia; 1983/84 was the driest for 50 years and many true desert butterflies failed (or almost failed) to emerge. This phenomenum has also been observed in *Papilio alexanor* in Palestine by NAKAMURA & AE (1977).

## PAPILIONOIDEA (TRUE BUTTERFLIES)

### Fam. **Papilionidae**

#### Subfam. **Papilioninae**

***Papilio saharae saharae*** Oberthür, 1879

*Papilio machaon saharae* Oberthür, 1879. Et. ent. *4:* 68.

Range: On 27. III. 1983 a single male was captured at 1500 m some 50 km south-east of Haql in NW Saudi Arabia and larvae were found on *Ferula sinaica.* This foodplant was quite common along both Haql ridges and the subspecies may be far more widespread than indicated. Interestingly, the Asir race, *rathjensi* Warnecke, fed on *Pycnocycla* (Umbelliferae). In both, the Jebel Shammar and Jebel Tuwayq, another known foodplant, *Pituranthos triradiatus,* was locally common. Occasional records of "*P. machaon* L." from central and northern Saudi Arabia (WILTSHIRE 1945) may have in fact been individuals of this species which had strayed from local colonies, which would be hard to find.

Habitat: North facing slopes and gullies on steep hillsides above 1500 m.

Early stages: Larvae were very distinct from its sister species *P. machaon* L., with which it is usually allied. Fully grown the basic ground colour was white with a complex, crenellated pattern of black stripes and checks. Each segment bore an encircling band of orange dots and there was also a pronounced ventro-lateral band of the same colour along the entire caterpillars side.

Comments: In April 1984 neither adults nor larvae were to be found and the foodplant was suffering badly from drought. This led to the conclusion that *P. saharae* had "skipped" a year to escape unfavourable conditions, as *P. alexanor maccabaeus* Staudinger occasionally appears to do (NAKAMURA & AE 1977).

***Papilio saharae rathjensi*** Warnecke, 1932

*Papilio machaon rathjensi* Warnecke, 1932. Int. ent. Z. *25:* 473.

Range: Originally thought to be confined to the high mountains of North Yemen above 2300 m, this subspecies was also found in discrete colonies along the Asir as far north as 100 km short of Taif. There appeared to be upward of three generations a year, depending on rainfall. In 1983 adults were seen at Aduan in mid February, late March and late May. 1984, a very dry year, yielded only one prolonged emergence from mid February to late March, with a peak on 17.II.1984.

Habitat: Confined to steep, grassy, northeast facing hillsides just inland of the *Olea* zone, between 1500 and 2000 m. Drainage lines in such areas tended to be lined with *Rhus, Pistacia* and *Jasminum.*

Early stages: Mature larvae were as per *P.s. saharae,* however, in the Asir the sole foodplant appeared to be *Pycnocycla glauca* (Umbelliferae). *Ferula,* the main host in Yemen (LARSEN 1983), was exceedingly rare. Initially, the ova were laid singly on the curious three pronged leaves, on which the young larvae also fed. Later, as the leaves died back, oviposition switched to the smaller stems and flowerheads and it was here that the larger larvae fed; many preferred the very green stem cuticle to flowers and generally left white channels up a stalk. Pupation was away from the foodplant on some shady rock, with diapause lasting upward of three years (a pupa collected in July 1982 still had not emerged by August 1984).

Comments: This species provided one of the best examples of hilltopping courtship behaviour of any Saudi butterfly. On 17.II.1984, on a 20 × 20 m peak directly above the Aduan colony, upward of 20 males were observed over three hours cavorting about and chasing females which came up to mate. Numerous other hilltopping butterflies were also present, most notably *Lepidochrysops pittawayi* Larsen.

***Papilio demoleus demoleus*** Linné, 1764

*Papilio demoleus* Linné, 1764. Mus. Ulr.: 214.

Range: Due to widespread cultivation of *Citrus* trees this species has gradually crept westwards across Saudi Arabia as far as Buraydah (PITTAWAY 1981), and now Najran. There is no doubt that *P. demoleus* will soon overlap with the range of *P. demodocus* Esper, if it has not already done so. Flew throughout the year except for the cold period from November to February.

Habitat: Strictly orchards and gardens.

Early stages: Only on cultivated *Citrus* species.

***Papilio demodocus demodocus*** Esper, 1798

*Papilio demodocus* Esper, 1798. Ausl. Schmett.: 205.

Range: Originally confined to the Asir mountains and foothills, this species has only spread a short distance since the introduction of cultivated *Citrus.* It was found in most major towns on the Tihama as far north as Yanbu and inland to Medinah, Taif, An Nimaas and Khamis Mushait. Flew throughout the year with up to five peaks, although in the Asir it disappeared from November to January.

Habitat: Gardens, farms, and wooded areas on the Asir escarpment where *Ruta* grew.

Early stages: Originally on *Teclea* and *Ruta chalepensis* in the Asir up to 2300 m, and on various *Haplophyllum* species inland from Jizan. Now also on cultivated *Citrus*. Ova laid on *Murraya paniculata* in Jeddah gardens never developed beyond the first instar and *P. demoleus* refused to lay on this Asian member of the orange family.

It was interesting to note that all mature larvae on *Citrus* were always the "normal" green and white colour, whereas those on *Ruta* and *Haplophyllum* varied between "normal" and the mottled brown, yellow and white examples which predominated in Dhofar, Oman. This latter pattern was very effective in breaking up the larval outline against a soil/rock background. This would have been a distinct survival advantage as both of these herbaceous plants were not very leafy.

## Fam. **Pieridae**

### Subfam. **Pierinae**

***Mylothris arabicus*** Gabriel, 1954

*Mylothris arabicus* Gabriel, 1954. BMNH Exp. SW Arabia *1:* 364.

Range: North Yemen to the southern Asir (Suda). The species appeared to have a number of generations, with Saudi examples having been found in mid September, February/March and May.

Habitat: Large wadis running inland from the escarpments edge which were heavily wooded with mature *Acacia hamulosa* and *A. etbaica* trees.

Early stages: On *Loranthus* growing on the above *Acacia* trees.

***Artogeia rapae leucosoma*** (Schawerda, 1905)

*Pieris rapae* var. *leucosoma* Schawerda, 1905. Verh. zool.-bot. Ges. Wien *55:* 516.

Range: It has been found around Unayzah and Buraydah in northern Saudi Arabia (Pittaway 1981) and was also found to be firmly established on cultivated cabbage and radish in the Jebel Shammar around Hail and around Riyadh. Flew in March and April.

Habitat: Farms and oases only.

***Pontia daplidice daplidice*** (Linné, 1758)

*Papilio daplidice* Linné, 1758. Syst. Nat., ed. X: 468.

Range: The species occupied the entire Asir *Juniperus* and *Olea* zones of southwestern Saudi Arabia, from Taif to the Yemen border. Flew from mid February to mid November, but with a noticable drop in numbers from June to September.

Habitat: Cultivated field edges and silty washes.

Early stages: On *Caylusea (=Reseda) hexagyna*.

***Pontia glauconome*** (Klug, 1829)

*Synchloe glauconome* Klug, 1829. Sym. Phys., text pl. 7, figs 18–19.

Range: Found across the entire western region of Saudi Arabia up to 2000 m, where it was replaced by *P. daplidice*. On the wing throughout the year, but the total numbers of broods and individuals were highly dependent on rainfall. Commonest from November to May.

Habitat: Sandy washes, wadis, rocky hillsides and alluvial fans.

Early stages: On *Dipterygium glaucum* (Capparidaceae) and, inland from the western highlands,

*Ochradenus* sp., *Diplotaxis harra, Caylusea hexagyna, Moricandia sinaica* (a favourite in the Jebel Tuwayq), *Zilla spinosa* and other wild Cruciferae. As noted in Qatar, pupae in very exposed situations were almost pure chalk-white in colour (PITTAWAY 1980).

***Euchloe aegyptiaca*** Verity, 1911

*Euchloe belia* race *aegyptiaca* Verity, 1911. Rhop. Pal.: 337.

Range: From Libya through Egypt to Jordan and Saudi Arabia. It occurred in the latter country in only two areas – the second mountain range inland from Haql and the Jebel Shammar, in both instances above 1000 m. Adults were to be seen from late March to mid April, but individual numbers varied greatly from year to year.

Habitat: Deep rocky gullies on hillsides, especially ones with silt-lined depressions.

Early stages: Ova were laid in both localities on the flowerheads of *Isatis lusitanica* (Cruciferae).

Comments: It was interesting to note that inland from Haql a certain degree of ecological segregation between this butterfly and others took place. Whereas *E. aegyptiaca* and *Papilio saharae* were confined to the cooler and higher *Colutea* strewn second ridge, other species normally associated with these two, such as *Melitaea deserticola, Elphinstonia charlonia, Euchloe falloui* and *Zegris eupheme,* preferred the drier, first ridge.

***Euchloe belemia belemia*** (Esper, 1799)

*Anthocharis belemia* Esper, 1799. Schmett. Abb. Beschr.: 10.

Range: In western Saudi Arabia it was confined to the same ecological zone as *Pontia daplidice,* i.e. the Asir *Juniperus* and *Olea* woodlands above 2000 m, from Taif to the Yemen border. Flew from February until April.

Habitat: The fringes of cultivated fields and disturbed ground.

Early stages: On *Sisymbrium irio* L., a common weed of wheat and other ploughed fields.

***Euchloe falloui saudi*** Larsen, 1983

*Euchloe falloui saudi* Larsen, 1983. Fauna of Saudi Arabia *5:* 353–354.

Range: As ssp. *saudi* along the Jebel Tuwayq and, possibly, the Hejaz foothills around Makkah. Contrary to LARSEN (1983), neither this nor the nominate subspecies has been seen in the Jebel Shammar with any certainty. Univoltine between February and April, depending on the weather.

Habitat: On *Moricandia sinaica* in the Jebel Tuwayq, but some other plant must host this species further west. A full description of this butterfly's life-cycle is given in PITTAWAY (1981), but it has since been discovered that pupae can diapause over a number of years. One example from 1980 suddenly formed up and emerged within three days during 1984.

***Euchloe falloui falloui*** (Allard, 1867)

*Anthocharis falloui* Allard, 1867. Ann. Soc. ent. France *7:* 312–318.

Range: So far, the only known Saudi examples were collected during late March and early April along the first inland ridge from Haql. (This subspecies may also extend down the Hejaz mountains to Makkah).

Habitat: Silty depressions at the base of slopes, and small wadis.

Early stages: On *Zilla spinosa.* NAKAMURA & BENJAMINI (1973) suggested this foodplant from the Negev.

Comments: Specimens collected in the "normal" spring of 1983 had clearly defined green bands on the hindwing undersides. 1984, a very dry year, produced adults with much paler, broken stripes

infused with yellow. These very closely resembled ssp. *saudi* from Makkah, which may, therefore, be a dry zone form similar to f. obsolescens Rothschild, 1913 from the central Sahara. However, bred examples from the Tuwayq Hills were typical ssp. *saudi* regardless of what conditions they were reared under.

***Zegris eupheme larseni*** n. ssp.

*Papilio eupheme* Esper, 1805. Schmett. Abb. Natur: 113, 2, 3.

Range: Apparently confined in Saudi Arabia to the NW hills inland from Haql, at around 1000 m. Numerous specimens were caught on 26./27.III.1983 which differed markedly from ssp. *tigris* Riley and ssp. *uarda* Hemming from Jordan. However, the Saudi population was clearly linked to the single female specimen captured in southern Jordan (Wadi Rum 1977) by Larsen and figured in LARSEN & NAKAMURA (1983). It is here described as a new subspecies.

Habitat: Well vegetated gullies on steep hillsides.

Early stages: Not known, although ssp. *uarda* feeds on *Erucaria boveana* in Palestine.

Description: Male (underside): Forewing apex 80% to 100% lemon-yellow as opposed to less than 50% in ssp. *uarda.* Yellow-black suffusion on hindwings extensive, covering more than 80% of the surface area. Between the basal area and anal angle this suffusion extends twice to the wings inner margin, with small white patches being left approximately half-way down and at the anal angle itself. Costa as per ssp. *uarda,* but the entire post discal and marginal areas, from the apical to the anal angle, more than 70% yellowish black, i.e. yellow with an overlay of black scales. In ssp. *uarda* this area is more than 70% white. Median area solidly yellow-black as in ssp. *uarda.* Female (underside): The same patterning, but with the yellow black areas even more extensive.

Excellent colour photographs of both male and female ssp. *larseni* are given in LARSEN (1983).

Holotype: ♂, Saudi Arabia, 25 km SE Haql 27.III.1983, A.R. Pittaway leg. et coll. Paratypes: 2 ♂ (same data), 1 ♀, Saudi Arabia, 25 km SE Haql 26.III.1983, A.R. Pittaway leg. et coll.; 1 ♀, Jordan, Wadi Rum 1977, T.B. Larsen leg. et coll.

This subspecies is named in honour of Dr. Torben B. Larsen for his extensive work on the middle eastern butterflies.

Comments: This typical Irano-Turanian butterfly had a very characteristic, rapid and straight flight up and down gullies. It was abundant in 1983, but totally absent in the very dry spring of 1984.

***Elphinstonia charlonia charlonia*** (Donzel, 1842)

*Anthocharis charlonia* Donzel, 1842. Ann. Soc. ent. France *11:* 197.

Range: In late March 1983 numerous colonies were found both 25 km SE of Haql and in the Jebel Shammar around Hail, at aproximately 1000 m. In 1984 *E. charlonia* was absent from both localities, but the species was obviously resident as it had been previously recorded near Hail (LARSEN 1983). In Jordan the species can be multibrooded between November and May (LARSEN & NAKAMURA 1983).

Habitat: Steep, rocky slopes with a good supply of small, flowering plants.

Early stages: On *Diplotaxis harra* flowerheads.

***Anaphaeis creona leucogyne*** (Butler, 1885)

*Belenois leucogyne* Butler, 1885. Proc. zool. Soc. Lond.: 492.

Range: As ssp. *leucogyne* confined to southwestern Arabia. It inhabited the *Ficus salicifolia* zone on the west facing Asir escarpment whence it often flew up into the highest *Juniperus* zone. On the wing in April as far north as the Ad Dahna waterfalls (80 km north of Abha).

Early stages: On *Capparis tomentosa* (LARSEN 1983).

***Anaphaeis aurota*** (Fabricius, 1793)

*Papilio aurota* Fabricius, 1793. Ent. Syst. *3(1)*: 197.

Range: In western Saudi Arabia almost anywhere as a migrant, but resident along the Asir escarpment below 1000 m and in the foothills. On the Tihama south of Jeddah/Makkah most populations were nomadic, frequently shifting location. Found throughout the year, but commonest from December to April.

Habitat: Silty desert depressions, alluvial fans and wadi sand-bars, stands of *Maerua,* rocky scarps with *Capparis* etc.

Early stages: On *Capparis cartilaginea, Maerua crassifolia, Maerua oblongifolia* (climber) and, occasionally, *Boscia.*

Comments: On 8.XII.1982 Jeddah was inundated by a migrant swarm, some of which stopped to breed on *M. oblongifolia* along wadi washes and waste ground.

***Pinacopteryx eripha tritogenia*** (Klug, 1829)

*Pontia tritogenia* Klug, 1829. Sym. Phys., text pl. 7: 18–19.

Range: In Saudi Arabia confined to the *Ficus salicifolia* zone of the Asir escarpment as far north as Taif. Seen on the wing from May to December (hot season).

***Calopieris eulimene*** (Klug, 1829)

*Pontia eulimene* Klug, 1829. Sym. Phys., text pl. 7: 5–8.

Range: In Saudi Arabia strictly confined to a narrow belt, about 50 km wide, running down the centre of the Tihama, from Makkah to the Yemen border. Flew from August to December.

Habitat: Wadi fringes and desert depressions amongst sanddunes.

Early stages: Only on *Capparis decidua,* with ova being deposited on the very tips of new shoots.

Comments: Isolated *Capparis* bushes in the middle of nowhere often supported thriving colonies of this butterfly.

***Colotis calais amatus*** (Fabricius, 1775)

*Papilio amatus* Fabricius, 1775. Syst. Ent.: 476.

Range: Widespread on the Tihama and in the Asir (both eastern and western slopes) up to 1500 m, where *Salvadora persica* was present. Extended as far north as Taif and probably beyond, with adults on the wing from September to April.

Habitat: Rocky slopes bordering wadis, wet desert depressions etc., i.e. anywhere where *Salvadora persica* was present.

Early stages: On *Salvadora persica.*

***Colotis phisadia phisadia*** (Godart, 1819)

*Pieris phisadia* Godart, 1819. Enc. Méth. *9*: 132.

Range: In Saudi Arabia it followed the distribution of *C. calais* although it extended further north up the Hejaz foothills, at least as far as Wejh. It is a known migrant and specimens were seen far from any suitable breeding sites. Flew from September to April.

Habitat: Places where *S. persica* grew.

Early stages: On *Salvadora.* Larvae gregarious, less so when mature. At this latter stage they were pale green, finely pilose, with a narrow yellow dorsal line interupted in some by white or pink triangles or blotches. Very active.

***Colotis chrysonome chrysonome*** (Klug, 1829)

*Pontia chrysonome* Klug, 1829. Sym. Phys., text pl. 7, figs. 9–11.

Range: In Saudi Arabia it apparently flew in two broods, September to early November and from April to June on the southern Tihama plain. From the Bahra/Makkah area north to Wejh along the Hejaz foothills it was only found in one brood during April/June, although an odd specimen was captured in July 1984.

Habitat: *Acacia* dotted gullies on hot slopes where the adult liked to spend a lot of time resting in the shade. Commonest in the *F. salicifolia* zone on the Asir escarpment.

Early stages: On *Maerua crassifolia* and *M. oblongifolia.*

***Colotis protomedia*** (Klug, 1829)

*Pontia protomedia* Klug, 1829. Sym. Phys., text pl. 8, figs 13–16.

Range: In Saudi Arabia it was confined to the Asir escarpment and foothills, and lava flows running out onto the Tihama, as far north as Jeddah/Taif. On the wing from May to November, with odd specimens the rest of the year.

Habitat: The fringes of light woodland.

Early stages: On *Maerua oblongifolia* and, very occasionally, *M. crassifolia.*

***Colotis halimede halimede*** (Klug, 1829)

*Pontia halimede* Klug, 1829. Sym. Phys., text pl. 7, figs 12–15.

Range: The southern Tihama and Asir foothills to just north of Makkah, with adults on the wing from November to April.

Habitat: Shrubberies of *Cadaba rotundifolia* on the open Tihama as well as drainage lines along hot lava flows in the Asir foothills.

Early stages: On *C. rotundifolia* and *C. glandulosa.*

***Colotis pleione pleione*** (Klug, 1829)

*Pontia pleione* Klug, 1829. Sym. Phys., text pl. 8, figs 7–8.

(Data as for *C. halimede,* but a much rarer species).

***Colotis danae eupompe*** (Klug, 1829)

*Pontia eupompe* Klug, 1829. Sym. Phys., text pl. 6, figs 11–14.

Range: The Asir escarpment and foothills, as well as the Tihama, as far north as Yanbu. Flew throughout the year.

Habitat: Overgrown wadis, gullies, shrubberies, scrub etc., in dry, rocky areas.

Early stages: On small-leaved *Cadaba* species. Mature larva 20 mm, blue-green, finely pilose, with a dense covering of small white dots. The fore segments were slightly swollen and there was a pale lemon dorsal line. Interestingly, the entire body bore a number of widely spaced tubular bristles which exuded an orange liquid when stimulated by ants. The animal was extremely lethargic and never made any attempt to escape the attentions of these otherwise fierce predators.

***Colotis eucharis evarne*** (Klug, 1829)

*Pontia evarne* Klug, 1829. Sym. Phys., text pl. 6, figs 1–4.

Range: Rocky outcrops on the Tihama, as well as along the Asir foothills, as far north as Medinah. On the wing from November to April (cool season).

Habitat: Seasonal undergrowth under stands of mature trees.

Early stages: On *Cadaba* species.

**Colotis antevippe ?zera** (Lucas, 1852)

*Teracolus zera* Lucas, 1852. Rev. Zool. *4* (ser. 2): 425.

Range: A single male was captured flying furiously along a steep gully in the *Ficus salicifolia* zone on the Abha escarpment (27.IX.1982). This appears to be the only Saudi Arabian record.

**Colotis daira daira** (Klug, 1829)

*Pontia daira* Klug, 1829. Sym. Phys., text pl. 8, figs 1–4.

Range: The *F. salicifolia* zone of the Asir escarpment south of Abha and thence out onto the Tihama plain along rocky ridges. Only seen during September and October.

**Colotis liagore** (Klug, 1829)

*Pontia liagore* Klug, 1829. Sym. Phys., text pl. 6, figs 5–8

Range: The Tihama as far north as Yanbu, although around Jizan it was rather rare. Also, both sides of the Asir to 1500 m and, as an isolated population, the Jebel Tuwayq (Pittaway 1979, 1981). Seen from April until December.

Habitat: Rocky hillsides and *Acacia/Maerua* parkland with a scattering of shrubs.

Early stages: On *Maerua crassifolia* and, occasionally, *Capparis cartilaginea.*

Comments: A variable species with most females heavily marked with black. Most also had some degree of reddish-brown scaling on the hindwing undersides.

**Colotis evagore evagore** (Klug, 1829)

*Pontia evagore* Klug, 1829. Sym. Phys., text pl. 8, figs 5–6.

Range: The Tihama plain as far north as Yanbu. Flew from November to April.

Habitat: Stands of *Cadaba rotundifolia* as well as both the *Acacia/Maerua* and *Acacia/Commiphora* associations.

Early stages: On *Cadaba, Capparis* and probably *Maerua.*

**Colotis eris contractus** Gabriel, 1954

*Colotis eris contractus* Gabriel, 1954. BMNH Exp. SW Arabia *1:* 370.

Range: The Asir escarpment *Ficus salicifolia* zone as far north as Taif. Observed from September to November, but rare. Addicted to the flowers of *Maerua oblongifolia.*

**Madais fausta fausta** (Olivier, 1804)

*Papilio fausta* Olivier, 1804. Voyage Othoman *4:* 29.

Range: The Asir, between 500 and 1500 m, as well as the Hejaz highlands as far north as Medinah. There is also a population in the Jebel Tuwayq (Pittaway 1979). Flew throughout the year with occasional peaks.

Habitat: Rock faces, cliffs and canyons. However, near Riyadh this species also frequents abondoned oases and the fringes of those under cultivation.

Early stages: On *Capparis* species only.

**Nephronia buqueti buchanani** Rothschild, 1921

*Nephronia buqueti buchanani* Rothschild, 1921. Novit. Zool.: 151.

Range: The Tihama as far north as Al Lith. Commonest during April, but generally flew all summer.

Habitat: Stands of *Salvadora persica* in lowland depressions.

Early stages: On *S. persica.*

Subfam. **Coliadinae**

***Catopsilia florella*** (Fabricius, 1775)

*Papilio florella* Fabricius, 1775. Syst. Ent.: 479.

Range: Resident on the Tihama as far north as Makkah/Jeddah, but found as a migrant all over the western region. Flew throughout the year, but commonest during August/September and April, i.e. the periods of greatest rainfall.

Habitat: Wadi fringes, wet desert depressions and gardens.

Early stages: South of Jeddah, on the Tihama, the natural foodplant was *Cassia senna.* To the north and east migrants transferred to *Cassia italica,* however, the cultivation of ornamental *Cassia* species in towns had had a profound effect on local populations. In Jeddah it thrived on *C. alata,* less so on *C. fistula* and did not do at all well on *C. multijuga, C. occidentalis* and *C. corymbosa,* although it oviposited on all three of the latter.

***Eurema hecabe solifera*** (Butler, 1875)

*Terias solifera* Butler, 1875. Ann. Mag. nat. Hist. *15:* 396.

Range: The entire southern Tihama, from Medinah to the Yemen border, and up into the Asir *Olea* zone. Flew throughout the year, but at higher altitudes absent from November to March. Dry area generations very dependent on rainfall.

Habitat: Luxuriant seasonal growth fringing wadis, under stands of trees and along gullies.

Early stages: On most pinnate leaved Leguminosae, including *Lotus arabicus* from the Asir.

***Colias erate marnoana*** Rogenhofer, 1883

*Colias marnoana* Rogenhofer, 1883. Verh. zool.-bot. Ges. Wien *33:* 22.

Range: The high Asir, from Taif/Al Hada to Yemen. Two males were collected on a farm at Al Hada on 20.VIII.1982, but the species did not appear to be resident. It probably sporadically invades from Ethiopia and Somalia.

Habitat: Farms with cultivated fields of *Medicago sativa,* as well as water meadows in the Asir *Juniperus* zone.

***Colias croceus*** Geoffroy, 1785

*Colias croceus* Geoffroy, in Fourcroy 1785. Ent. Paris: 250, no. 48.

Range: In western Saudi Arabia there were permanent populations in the Jebel Shammar and Jebel Tuwayq, with the latter penetrating as far south as Najran (SE of Abha). It may turn up in other parts of the Asir, especially since *M. sativa* is now cultivated on even the smallest Nejd farm. In eastern Saudi Arabia it has managed to spread very rapidly using such farms as "stepping stones". Seen from March to June.

Habitat: Strictly cultivated fields of *M. sativa,* as well as desert depressions.

Early stages: On *M. sativa* and the wild *M. aschersoniana.*

***Colias electo meneliki*** Berger, 1940

*Colias electo meneliki* Berger, 1940. Expl. P.N.A., Mission G. de Witte *30:* 44.

Range: The Asir *Juniperus* and *Olea* zones, from Taif/Al Hada to the Yemen border. On the wing from April to November.

Habitat: Fields of *Medicago sativa* on farms, as well as water meadows and stream fringes above 1300 m.

Early stages: On *Medicago* and *Lotus* species.

Comments: There is a single specimen recorded from Khayber (Khaibar) in the northern Hejaz (Larsen 1983). This may well have been *C. croceus.*

## Fam. **Lycaenidae**

### Subfam. **Theclinae**

***Myrina silenus nzoiae*** Stoneham, 1937

*Myrina silenus nzoiae* Stoneham, 1937. Stoneham Mus. Bull. Kitale *34:* 1–3.

Range: The *Ficus salicifolia* zone along the entire Asir escarpment, from Taif/Al Hada to North Yemen. Flew from July to February, with a peak in August.

Habitat: Stands of *F. salicifolia* along steep, rocky wadis and gullies.

Early stages: On *F. salicifolia.*

Comments: An occasionally abundant species, usually closely associated with its foodplant, but with some hilltopping to 3000 m.

***Axiocerces harpax kadugli*** Talbot, 1935

*Axiocerces harpax kadugli* Talbot, 1935. Ent. month. Mag. *71:* 120.

Range: The high Asir above 1500 m, from Taif (Shafha) to the Yemen border. On the wing from March to November.

Habitat: Clearings and wadi margins in mixed *Acacia* woodland, i.e. *Acacia/Olea* or *Acacia/Juniperus.*

Early stages: On *Acacia* leaves.

***Epamera glaucus*** (Butler, 1886)

*Iolaus glaucus* Butler, 1886. Proc. zool. Soc. London (1885): 667.

Range: The Asir foothills and escarpment from Yemen to Taif/Al Hada. Also, *Acacia* lined wadis running inland from the Asir at 1300 m. Flew in what apeared to be two broods, late September to early November, and again in May.

Habitat: Dense stands of *Acacia* parasitised by *Loranthus acaciae.* Adults spent most of their time sitting on high branches in little group or, occasionally, zooming at high speed around the trees crown.

Early stages: On *Loranthus.*

Comments: This species probably also occurs along the entire Hejaz highlands as conditions there are most suitable. It has been found near Aqaba.

***Epamera nursei*** (Butler, 1896)

*Iolaus nursei* Butler, 1896. Proc. zool. Soc. London: 251.

Range: Middle hights of the Asir (1000–1500 m), from Taif to Yemen. On the wing from October to January.

Habitat: Rather dry, flat wadis lined with large trees of *Acacia asak* and *A. hamulosa* parasitised with the red flowering *Loranthus acaciae.*

Early stages: On *Loranthus acaciae.*

Comments: A rather local species with very low population densities. Spent most of its time up in the crown of large *Acacia* trees and rarely strayed lower than three meters.

***Hypolycaena philippus philippus*** (Fabricius, 1793)

*Papilio philippus* Fabricius, 1793. Ent. Syst. *3:* 283.

Range: The *Ficus salicifolia* zone of the Asir escarpment, from Taif/Al Hada to the Yemen border. Appeared to have four generations a year, with adults in September, November, January and April. (Due to drought the first two generations did not emerge in 1983/84).

Habitat: Bushes and trees overgrown with *Coccinia grandis* (Cucurbitaceae). A forest edge species.

Early stages: On *C. grandis.*

***Deudorix livia*** (Klug, 1834)

*Lycaena livia* Klug, 1834. Sym. Phys., text pl. 40, figs 3–6.

Range: The high Asir above 1300 m, the Hejaz mountains north to El Ula and, as a migrant over much of western Saudi Arabia. On the wing from August to February.

Habitat: *Acacia* forest and parkland.

Early stages: In *Acacia* seedpods.

## Subfam. **Lycaeninae**

***Lycaena phlaeas shima*** Gabriel, 1954

*Lycaena phlaeas shima* Gabriel, 1954. BMNH Exp. SW Arabia *1:* 388.

Range: The Asir *Olea* and *Juniperus* zones (1800 to 3000 m). Flew all year round, from Taif/Al Hada to North Yemen.

Habitat: Gravelly river-beds, disturbed ground, cultivated areas, ravine sides, i.e. almost anywhere where *Rumex* was to be found.

Early stages: On various *Rumex* species.

## Subfam. **Polyommatinae**

***Anthene amarah amarah*** (Guérin, 1849)

*Polyommatus amarah* Guérin, 1849. Lef. Voy. Abyss.: 384.

Range: The Tihama plain and Asir mountains north to at least Yanbu and El Ula, and inland over much of the Nejd plateau. Flew throughout the year, but commonest during November/December.

Habitat: *Acacia* forest and parkland.

Early stages: On *Acacia* leaves.

***Anthene arora*** Larsen, 1983

*Anthene arora* Larsen, 1983. Fauna of Saudi Arabia *5:* 389–391.

Range: The *Juniperus* zone (1800 m plus), from North Yemen as far north as Athnen. Commonest around 2500 m, where *Erica arborea* occurred. Two broods recorded, one in July, the other, much larger one, in September/October.

Habitat: The fringes of water courses through dense stands of *Juniperus/Acacia* woodland. It tended to share the same areas with *Cacyreus virilis* Aurivillius.

Comments: Where it occurred it tended to be the only butterfly flying at that time.

***Lampides boeticus*** (Linné, 1767)

*Papilio boeticus* Linné, 1767. Syst. Nat., ed. XII: 789.

Range: Almost anywhere where its very wide selection of foodplants could be found. Flew all year round, but commonest during the cooler months November–April.

Habitat: Farms, gardens, towns, desert depressions, mountain meadows etc.

Early stages: On *Sesbania aegyptiaca, Medicago sativa, Indigofera* sp., *Tephrosia* sp., *Crotalaria emarginella* etc., usually in the seedpods.

***Cacyreus virilis*** (Aurivillius, 1924)

*Cupido virilis* Aurivillius, 1924. Seitz Macrolep. *13:* 463.

Range: The Asir *Juniperus* zone above 1800 m, from North Yemen to Athnen. Only seen during May, but may fly in August as well, as per Dhofar, Oman.

Habitat: The sides of small streams in "densely" wooded areas, especially where *Lavandula* and *Salvia* were common.

***Syntarucus pirithous*** (Linné, 1767)

*Papilio pirithous* Linné, 1767. Syst. Nat., ed. XII: 790.

Range: The entire Asir escarpment. Flew from September to May.

Habitat: Mountain meadows, rocky gullies and the base of cliffs where *Crotalaria* and *Indigofera* grew.

***Tarucus theophrastus*** (Fabricius, 1793)

*Papilio theophrastus* Fabricius, 1793. Ent. Syst. *3:* 281.

Range: The Asir escarpment and foothills as far north as Mikhwa. Only seen on the wing from January to March.

Habitat: Trees of *Zizyphus spina-christi* in medium to large wadis.

Early stages: On *Z. spina-christi.*

***Tarucus rosaceus*** (Austaut, 1885)

*Lycaena theophrastus* var. *rosaceus* Austaut, 1885. Le Naturaliste *7:* 141.

Range: The Asir mountains and foothills inland to the Jebel Tuwayq. On the wing from September to May.

Habitat: Trees of *Z. spina-christi* in gullies, wadis and on farms.

Early stages: On *Z. spina-christi.*

***Zizeeria knysna*** (Trimen, 1862)

*Lycaena knysna* Trimen, 1862. Trans. ent. Soc. Lond. *3:* 282.

Range: The Tihama, from Yanbu to the Yemen border and, thence, inland up over the Asir mountains. Flew all year round with peaks of abundance.

Habitat: Farms, gardens, wadi fringes, desert depressions, streams, meadows etc.

Early stages: On *Medicago sativa, Lotus* sp., *Trigonella* sp. etc.

***Zizula hylax hylax*** (Fabricius, 1775)

*Papilio hylax* Fabricius, 1775. Syst. Ent.: 526.

Range: The Asir foothills and lower escarpment, from North Yemen to Mikhwa. Only seen in February.

Habitat: The edges of wadis fringed with a luxuriant growth of low annuals. Such water courses had running water for most of the year.

Comments: An easy way to tell this species from *Z. knysna* in the field is that *Z. hylax,* upon landing, leans slowly from side to side a number of times.

***Azanus jesous*** (Guérin, 1847)

*Polyommatus jesous* Guérin, 1847. Lef. Voy. Abyss. *6:* 383.

Range: The Hejaz and Asir foothills and mountains, from Jordan to North Yemen. On the wing from November to May and, sometimes, July.

Habitat: *Acacia* trees and shrubs on hillsides and along wadis. Adults flew very rapidly in and out of the branches.

Early stages: On various *Acacia* species.

***Azanus ubaldus*** (Cramer, 1782)

*Papilio ubaldus* Cramer, 1782. Pap. Exot. *4:* 209.

Range: As per the previous species, but also penetrating out onto the Nejd plateau as far inland as the Tuwayq Hills. Flew all year round, but with a marked peak in July, August and September up in the Asir.

Habitat: *Acacia* stands wherever they occurred.

Early stages: On various *Acacia* species, especially *A. tortilis, A. ehrenbergiana, A. etbaica* and *A. asak.*

***Azanus moriqua*** (Wallengren, 1857)

*Lycaena moriqua* Wallengren, 1857. Lep. Rhop. Caff.: 39.

Range: The Asir escarpment and foothills as far north as An Nimaas. Seen on the wing from July to September.

Habitat: *Acacia* lined streams, rivers and damp wadis. Very much a forest edge species.

Early stages: On *Acacia* species, especially *A. mellifera.*

***Pseudophilotes abencerragus nabataeus*** (Graves, 1925)

*Turania baton nabataeus* Graves, 1925. Trans. ent. Soc. Lond.: 62.

Range: The Jebel Shammar around Hail as an isolated population. An Irano-Turanian species which appears further north in eastern Jordan (Larsen & Nakamura 1983). Only seen in early April, although in Jordan *abencerragus* flies between mid March and early May.

Habitat: Gullies and areas of scree on steep, north facing, bolder strewn slopes with clumps of *Pistacia atlantica.* Typical herbaceous plants included *Astragalus spinosus, Polygala ?abyssinica, Micromeria biflora, Isatis lusitanica* etc.

Early stages: A female was seen investigating a *Micromeria* plant very closely.

***Lepidochrysops pittawayi*** Larsen, 1983

*Lepidochrysops pittawayi* Larsen, 1983. Fauna of Saudi Arabia *5:* 408–410.

Range: The *Juniperus* and *Olea* zones of the Asir mountains, from Al Foqa north to Taif/Al Hada. Flew from February to May in two to three broods. Localities: Al Hada (nr. Taif), Aduan (nr. Baha), Salran (nr. Biljurshi), Al Foqa.

Habitat: Mountain meadows, forest clearings and bolder-strewn hillsides with dense patches of *Lavandula dentata* intermixed with the much smaller *Micromeria biflora.* Above 2000 m.

Early stages: Ova were deposited on *M. biflora* (Labiatae), but it was unlikely that this species developed fully on this very small plant. Other *Lepidochrysops* sp. complete their lifecycles in ants nests.

Comments: A very local species, but often abundant in a good locality. On 17.II.1984 upward of 25 specimens were seen hilltopping with numerous *Papilio saharae* above Aduan in the Asir.

***Euchrysops lois*** (Butler, 1885)

*Catochrysops lois* Butler, 1885. Proc. zool. Soc. Lond.: 762.

Range: Eastern slopes of the Asir mountains, from 30 km north of Taif to the Yemen border. On the wing in November/December/January, mid March and again in late April and early May.

Habitat: Rather bare, dry, stony slopes between 1800 and 2700 m just inland of the *Olea* and *Juniperus* zones. Colonies were very closely bound to the distribution of the foodplant, *Campylanthus pungens* (Scrophulariaceae).

Early stages: Ovum china white and laid well down on the woody base of its foodplant to where the females crawled. Mature larva 12 mm with a prominant yellow lateral line and yellow edging to a red dorsal line. The rest of the body was yellow with fine red longitudinal lines which tended to become numerous in the dorso-lateral area. Head black. Fed by eating channels in the plants stem cuticle.

***Iolana alfierii*** Wiltshire, 1948

*Iolana alfierii* Wiltshire, 1948. Bull. Soc. Fouad *1* Ent. *32:* 219

Range: Confined to the Jebel al Lawz area, some 50 km SE of Haql, where *Papilio saharae* and *Euchloe aegyptiaca* occurred. Only found in late March.

Habitat: North facing, steep gullies above 1500 m where *Colutea istria* could be found.

Early stages: On *C. istria.*

***Agrodiaetus loewii uranicola*** (Walker, 1870)

*Lampides uranicola* Walker, 1870. Entomologist *5:* 52.

Range: The Jebel Tuwayq as well as the Hejaz mountains SE of Haql. On the wing during March and April. (For some reason it appeared to be absent from the apparently suitable Jebel Shammar.)

Habitat: Large, stony wadis (J. Tuwayq) and bolder strewn slopes (Hejaz) where *Astragalus spinosus* could be found.

Early stages: On *A. spinosus* and *A. sieberi.*

Comments: In the very dry winter and spring of 1983/84, this species, as well as *Melitaea persea sargon* Hemming, *Euchloe aegyptiaca, Plebejus pylaon philbyi* Graves and *Euchloe falloui saudi,* failed to emerge in the Jebel Tuwayq and J. Shammar, even after heavy late spring rains.

***Plebejus pylaon philbyi*** Graves, 1925

*Plebejus sephyrus philbyi* Graves, 1925. Trans. ent. Soc. Lond.: 55.

Range: The northern Tuwayq Hills (PITTAWAY 1981) and the entire Jebel Shammar area. Flew in March.

Habitat: Gullies on hillsides with *Astragalus spinosus.*

Early stages: On *A. spinosus.*

***Freyeria trochylus trochylus*** (Freyer, 1844)

*Lycaena trochylus* Freyer, 1844. Neu. Beitr. Schmett. *5:* 98.

Range: The Hejaz and Asir foothills and mountains, from Yanbu to North Yemen, as well as the Jebel Shammar. Flew all year round, but commonest in September, December and March.

Habitat: Wadi fringes, stony slopes, oasis fringes, desert farms etc.

Early stages: *Heliotropium* sp. and *Indigofera spinosa* formed the main diet.

## Fam. **Nymphalidae**

### Subfam. **Danainae**

***Danaus chrysippus chrysippus*** (Linné, 1758)

*Papilio chrysippus* Linné, 1758. Syst. Nat., ed. X: 471.

Range: The entire west of Saudi Arabia, but rare in the north. Flew all year round.

Habitat: Farms, desert depressions, oases, wadis, river banks and alluvial fans.

Early stages: On *Calotropis procera, Pergularia* sp., *Leptadenia pyrotechnica, Caralluma* sp. and, in the gardens of Jeddah, *Asclepias curassavica* and the native *Kahania laniflora.*

### Subfam. **Charaxinae**

***Charaxes hansali hansali*** Felder, 1867

*Charaxes hansali* Felder, 1867. Reise Novara, Lep.: 446.

Range: The entire Asir escarpment, from Taif/Al Hada to North Yemen, and up into the summit *Juniperus* and *Olea* zones. Flew from February until September.

Habitat: Well wooded gullies along the escarpments *F. salicifolia* zone, but often hilltopping to 2500 m.

### Subfam. **Nymphalinae**

***Byblia acheloia acheloia*** (Wallengren, 1857)

*Hypanis acheloia* Wallengren, 1857. Kgl. Svenska Vetensk. Akad. Handl., N.F. *3:* 29.

Range: The Asir and escarpment as far north as Muhayil. Only seen in November.

Habitat: Low herbage underneath large trees and shrubs on slopes and riverbanks.

***Vanessa cardui cardui*** Linné, 1758

*Papilio cardui* Linné, 1758. Syst. Nat., ed. X: 475.

Range: The entire western region, including the high Asir. Flew from August to May, but commonest from October to January.

Habitat: Basically rocky plains, hills and wadis, but as a migrant it was to be found anywhere.

Early stages: On *Forskohlea tenacissima* (Urticaceae) and *Malva* sp.

Comments: Although Larsen (1983) believed *V. cardui* incapable of surviving an Arabian summer, field observations demonstrated quite clearly that this butterfly was indeed resident in the Tuwayq Hills, over sections of the Nejd and in both the Hejaz and Asir foothills. Like *A. aurota,* the hot summer months were spent as a pupa which emerged with the onset of cooler weather. Populations in these areas built up and spread out to take advantage of winter growing annuals. In such a manner enormous numbers could build up in some areas which then migrated out leaving a nucleus behind. It must be said, however, that many populations in the region were "nomadic" and, like *A. aurota,* "shifted" location every few years due to changing environmental factors.

***Junonia orithya here*** Lang, 1884

*Junonia orithya here* Lang, 1884. Entomologist *17:* 206.

Range: Resident along the Asir escarpment and foothills. Ever so often, however, enormous num-

bers built up in an area which then "exploded" out across the Tihama, up into the high Asir and north up the Jebel Tuwayq as far as Riyadh. Such a migration was observed at Al Kharj on 2.V.1984, although in central Saudi Arabia the resultant populations only persist for a few years. Flew all year round, although rare from May to July.

Habitat: Rocky hillsides and gullies, oases, open riverine forest and farm fringes.

Early stages: On *Barleria* sp., *Blepharis* sp., and, in oases, *Lippia nodiflora*.

***Junonia hierta cebrene*** Trimen, 1870

*Junonia cebrene* Trimen, 1870. Trans. ent. Soc. Lond.: 353.

Range: The Asir foothills and escarpment. As a migrant north to Haql and the Jebel Tuwayq, where temporary populations established themselves. Flew all year round, but rather uncommon from May to July.

Habitat: Dry, stony hillsides and wadis with an extensive herbaceous flora.

Early stages: On *Barleria* sp. and *Blepharis ciliaris*.

***Precis limnoria niveistictus*** Gabriel, 1954

*Precis limnoria niveistictus* Gabriel, 1954. BMNH Exp. SW Arabia *1:* 361.

Range: The Asir escarpment, from Taif/Al Hada to the Yemen border (1000 to 2500 m). Seen from May to September.

Habitat: Well vegetated rocky gullies in the *Ficus salicifolia* zone, although it did fly up into the *Juniperus* regions.

***Hypolimnas misippus*** (Linné, 1767)

*Papilio misippus* Linné, 1767. Mus. Ulr.: 264.

Range: Resident in Jeddah, much of the Asir foothills south of Makkah as well as certain areas on the escarpment. As a migrant all over the southern Tihama and Asir mountains. Flew from October to April with an enormous peak in November/December.

Habitat: Well watered gardens, oases, river margins and pond fringes.

Early stages: On *Portulaca* sp., especially *P. oleracea.* Mature larva 30 mm, stout, dorsally matt black, with this colour breaking up laterally into brown. Longitudinal rows of black spines covered the body and there was a pair of such appendages protruding from an orange head.

***Melitaea persea sargon*** Hemming, 1932

*Melitaea didyma sargon* Hemming, 1932. Trans. ent. Soc. Lond. *80:* 272.

Range: Confined to the Tuwayq Hills. It did not occur in the Jebel Shammar and is unlikely to be found there as its foodplant is missing. Flew from February to May (Pittaway 1979), but this varied tremendously from year to year. In 1984, the very dry winter and spring resulted in no adults emerging.

***Melitaea deserticola scotti*** Higgins, 1941

*Melitaea abyssinica scotti* Higgins, 1941. Trans. R. ent. Soc. Lond. *9:* 236.

Range: Both *Juniperus* and *Olea* zones of the Asir mountains (1500 to 2500 m) and, possibly, the Hejaz highlands here and there. Flew from November to June in three to four broods, although in 1983/84 only one small brood emerged during February.

Habitat: Stony hillsides rich in herbaceous plants and lacking any tree cover.

Early stages: On the xerophytic *Kickxia pseudoscoparia* V. Graham & D. Sutton throughout the entire Asir. Mature larvae differed from *M. persea* in being matt black with orange legs, head and body cones. During cold weather most spent a great deal of time sunning themselves on the ground.

***Melitaea deserticola macromaculata*** Belter, 1934

*Melitaea deserticola macromaculata* Belter, 1934. Arb. morph. tax. Ent. *1:* 106.

Range: The first range of highlands inland from Haql, northwestern Saudi Arabia, at around 800 m. Flew in March.

Habitat: Stony hillsides rich in herbaceous plants.

Early stages: Possibly on *Kickxia aegyptiaca* (Linné) Nabelek, which occurred where this butterfly flew.

## Subfam. **Acraeinae**

***Acraea doubledayi azvaki*** Carcasson, 1981

*Acraea doubledayi azvaki* Carcasson, 1981. Collins handguide to the butterflies of Africa: 177.

Range: The Asir foothills as far north as Muhayil. Seen from September to January.

Habitat: Well vegetated dry wadis (small and large) above 500 m, from the *Acacia asak* zone up into the band of *Ficus salicifolia*.

***Acraea chilo chilo*** Godman, 1880

*Acraea chilo* Godman, 1880. Proc. zool. Soc. Lond.: 184.

Range: The Asir foothills as far north as Muhayil. Seen in November only.

Habitat: As per *A. doubledayi,* but more addicted to riverine forest.

## Subfam. **Satyrinae**

***Lasiommata felix*** (Warnecke, 1929)

*Pararge felix* Warnecke, 1929. Int. ent. Z. *22:* 365.

Range: The Asir mountains above 1800 m, from Taif/Al Hada to North Yemen. Seen from January to August.

Habitat: Steep mud banks, gullies, cliff faces, plantation ditches and wadi sides. In all cases within well vegetated areas.

***Ypthima asterope asterope*** (Klug, 1832)

*Hipparchia asterope* Klug, 1832. Sym. Phys., text pl. 29, figs II, 14.

Range: From the Asir and Hejaz foothills and mountains out onto the Tihama plain. Flew all year round with rainy season peaks.

Habitat: Oases, well vegetated hillside gullies, plantations, farms and shrubberies. Nearly always found in deep shade, often near water.

***Pseudotergumia tewfiki*** (Wiltshire, 1949)

*Eumenis tewfiki* Wiltshire, 1949. Bull. Soc. Fouad *1* Ent. 33: 353.

Range: The entire Asir *Juniperus* and *Olea* zones, from Taif/Al Hada to North Yemen, i.e. above 2000 m. On the wing from May to October with it being the commonest Asir butterfly during July.

Habitat: Very rocky, shrub strewn slopes with an abundance of grass. Adults spent a great deal of time sitting on the ground.

# HESPERIOIDEA (SKIPPERS)

## Fam. **Hesperiidae**

### Subfam. **Pyrginae**

***Caprona pillaana*** Wallengren, 1857

*Caprona pillaana* Wallengren, 1857. Kgl. Svenska Vetensk. Akad. Handl., N.F. *2:* 51.

Range: The Asir escarpment, from Abha to Yemen. Only seen in September and October.

Habitat: Well vegetated gullies in the *Ficus salicifolia* zone, especially those with *Grewia velutina.*

Early stages: On *G. velutina.*

***Sarangesa phidyle*** (Walker, 1870)

*Cyclopides phidyle* Walker, 1870. Entomologist *5:* 56.

Range: The entire Asir escarpment, from 500 to over 2000 m, as well as minor wadis running inland from that escarpment. Flew from November to May, being especially common around Taif/Al Hada during November.

Habitat: Narrow gullies with rocky overhangs under which it settled. Adults were very fond of *Pergularia* flowers.

***Spialia doris doris*** (Walker, 1870)

*Nisoniades doris* Walker, 1870. Entomologist *5:* 56.

Range: The Tihama as far north as Yanbu, as well as the Asir foothills and escarpment to 1500 m. It was also present on the gently sloping eastern inclines of the Asir as far inland as Bisha. Seen from August to April.

Habitat: Rocky wadis, gullies and desert depressions.

Early stages: On *Convolvulus histrix* over much of its range, as well as other *Covolvulus* sp. and *Corchorus* sp.

***Spialia colotes semiconfluens*** De Jong, 1978

*Spialia colotes semiconfluens* De Jong, 1978. Tijdschr. v. Entomol. *121:* 58.

Range: The Asir escarpment and foothills as far north as Taif/Al Hada. Flew from January to May.

Habitat: Dry, rocky gullies.

***Spialia mafa higginsi*** Evans, 1937

*Spialia mafa higginsi* Evans, 1937. Cat. African. Hesp.: 62.

Range: The Asir escarpment as far north as Taif/Al Hada. Only seen in September.

Habitat: Dry, rocky gullies.

***Gomalia elma elma*** (Trimen, 1862)

*Pyrgus elma* Trimen, 1862. Trans. ent. Soc. Lond. (1862): 288.

Range: The Tihama, Asir foothills and the Asir/Hejaz escarpments as far north as Yanbu. Flew from September to May.

Habitat: Well vegetated desert depressions, wadi fringes, oasis edges and hillside gullies with dense vegetation.

Early stages: On *Abutilon pannosum* and *A. fruticosum.*

### Subfam. **Hesperiinae**

***Pelopidas mathias mathias*** (Fabricius, 1798)

*Hesperia mathias* Fabricius, 1798. Ent. Syst., suppl.: 438.

Range: The Asir and Hejaz mountains as far north as El Ula, as well as the southern Tihama. It also occurs in the Jebel Tuwayq (Pittaway 1981). Seen from November to May.

Habitat: Farm fringes and stony wadis.

***Pelopidas thrax thrax*** (Hübner, 1821)

*Gegenes thrax* Hübner, 1821. Samml. Exot. Schmett. *2:* pl. 150.

Range: The southern Tihama and Asir foothills as far north as Mikhwa. Seen from January to April. (It also occurs locally at Riyadh [Pittaway 1981].)

Habitat: Farms, oases, river fringes. i.e. areas of dense, green vegetation.

Early stages: On wide-leaved, coarse grasses.

***Gegenes nostrodamus*** (Fabricius, 1793)

*Hesperia (=Urbicola) nostrodamus* Fabricius, 1793. Ent. Syst. *3:* 328.

Range: The Asir mountains and foothills as far north as Makkah. Seen from March to September. It also occurs in the Tuwayq Hills (Pittaway 1981).

Habitat: Oases, gardens, well vegetated gullies, especially where water was present.

***Gegenes gambica*** Mabille, 1878

*Gegenes gambica* Mabille, 1878. Petites Nouvelles *2:* 233.

Range: The Asir escarpment and Tihama south of Abha. Seen in November only.

Habitat: Farms, oases and river banks.

Early stages: On coarse grasses.

Comments: Populations in the eastern Mediterranean, Arabia and Africa are definitely *G. gambica,* with a chromosome number of n = 41. True *G. pumilio* from the western Mediterranean has n = 24. Both have been treated as one species in the past (Larsen 1983).

## ADDITIONAL SPECIES

Species which are known to occur in western Saudi Arabia, but which were not found during this survey, are listed below (after Larsen 1983).

Fam. **Pieridae**

*Colotis ungemachi* Le Cerf. Tihama north to Jeddah.

*C. evippe epigone* (Felder). One record – Najran, IX. 1978.

*C. ephyia* (Klug). An associate of *C. eulimene* on the southern Tihama.

*Eurema brigitta brigitta* (Stoll). Asir escarpment near Yemen.

Fam. **Lycaenidae**

*Hypolycaena pachalica* Butler. Asir escarpment near Yemen.

*Deudorix antalus* (Hopffer). Asir south of Abha.

*Tuxentius interruptus* (Gabriel). Asir escarpment near Yemen.

Plates 2–10: 2, Mature larva of *Papilio demodocus,* Jeddah. 3, Bred *Euchloe falloui saudi,* Diriyah. 4, Pupa of *Euchloe falloui saudi,* Diriyah. 5, Mature larva of *Catopsilia florella,* Jeddah. 6, Mature larva of *Tarucus rosaceus,* Riyadh. 7, Mature larva of *Euchrysops lois,* Taif. 8, Adult of *Melitaea deserticola scotti,* Taif. 9, Larva of *M. deserticola scotti,* Taif. 10, Pupa of *M. deserticola scotti,* Taif.

*Lepidochrysops forsskali* (Larsen). Asir escarpment near Yemen.
*Euchrysops osiris* (Hopffer). Southern Asir mountains.
*E. malathana* (Boisduval). Asir south of Abha.
*E. philbyi* Gabriel. Asir south of Abha, above 2300 m.

Fam. **Nymphalidae**
*Hamanumida daedalus* (Fabricius). Asir escarpment near Yemen.
*Eurytela dryope brittoni* Gabriel. Asir escarpment near Yemen.
*Junonia chorimene* (Guérin). Asir escarpment near Yemen.
*Acraea eponina* (Cramer). Asir escarpment near Yemen.
*A. neobule neobule* Doubleday. Asir escarpment near Yemen.
*A. encedon rathjensi* Le Doux. Asir south of Abha.
*Melanitis leda leda* (Drury). Asir escarpment near Yemen.

Fam. **Hesperiidae**
*Spialia spio* (L.). Asir escarpment near Yemen.
*Borbo gemella* (Mabille). Asir escarpment near Yemen.
*Gegenes hottentota* (Latreille). Asir escarpment near Yemen.

## POSSIBLE SPECIES

Besides those occurring in North Yemen which have not, as yet, been recorded from SW Saudi Arabia (see LARSEN 1983), there is the possibility that the following may be present in the north.

| Species: | Locality: |
|---|---|
| *Papilio alexanor maccabaeus* Staudinger | Haql mountains |
| *Pieris brassicae catoleuca* Rober | Migrant, Haql area |
| *Euchloe melisande* Fruhstorfer | Haql mountains |
| *Apharitis acamas acamas* Klug | NW |
| *Apharitis myrmecophila* Dumont | NW |
| *Strymonidia jebelia* Nakamura | Haql mountains |
| *Lycaena thersamon* Esper | Jebel Shammar |
| *Pseudophilotes sinaicus* Nakamura | Haql mountains |
| *Vanessa atalanta* L. | Migrant to NW |
| *Melitaea trivia syriaca* Rebel | Haql mountains |
| *Pseudotergumia pisidice* Klug* | Haql mountains |
| *Pseudochazara telephassa* Geyer | J. Shammar |
| *Syrichtus poggei* Lederer | J. Shammar |
| *Carcharodus stauderi ambigua* Verity | Haql mountains |
| *Thymelicus lineola fornax* Hemming | J. Shammar |
| *Borbo borbonica zelleri* Lederer | Migrant to NW |

* A specimen of *P. pisidice* Klug, 1832 was captured on 26.VI.1982 by Mr. Sarko Tilkian in the mountains west of Tabuk (Larsen, pers. comm.).

One area which has, as yet, been totally ignored lies just south and west of where the borders of Jordan, Iraq and Saudi Arabia meet. It would be well worth looking at during March, April and May.

## ACKNOWLEDGEMENTS

Many people have helped with the preparation of this paper by providing suggestions, data, specimens and support. Special thanks must go to Mr. P. Ackery, Mrs. R. Arora, Dr. D. Hillcoat (plants), Dr. T.B. Larsen, Mr. R. Vane-Wright, Mr. E.P. Wiltshire and, of course, the British Museum of Natural History entomology and botany staff in general.

Last, but not least, a special thanks to my former employers, Arabian Homes Co. Ltd., for allowing me to disappear into the wilderness ever so often on collecting trips.

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# Diptera: Fam. Bibionidae and Scatopsidae of Saudi Arabia

**J.-P. Haenni**

Abstract: The Palaearctic species *Dilophus tridentatus* Walker (Bibionidae) and *Swammerdamella brevicornis* (Meigen) (Scatopsidae) are recorded for the first time from Saudi Arabia and this is also the first mention of both families from this country. The male hypopygium of *D. tridentatus* is figured for the first time.

Keywords: Diptera, Bibionidae, Scatopsidae, Zoogeography.

ذوات الجناحين : عائلتان Bibionidae و Scatopsidae
في المملكة العربية السعودية
ج . ب . هاني

خلاصة : تم للمرة الاولى تسجيل Swammerdamella brevicornis (Meigen) و Dilophus tridentatus Walker (Bibionidae)
(Scatopsidae) هو النوع الذي ينتمي الى المنطقة الاوروبية ـ السيبيرية وذلك في المملكة العربية السعودية وهذه هي
المرة الاولى التي تذكر فيها العائلتان في هذه البلاد . وقد تم رسم ذكر عصقو ل الـ D. tridentatus لاول مرة .

The present material was collected by Prof. Dr. W. Büttiker, Jeddah, and Prof. Dr. A.S. Talhouk, Riyadh. Though containing only 2 species, these are nevertheless the first representatives of both families from Saudi Arabia.

## Fam. **Bibionidae**

Bibionidae of the Middle East are very poorly known: there is no general work or list and the rare records are scattered among the literature. The fauna of Egypt listed by Steyskal & El-Bialy (1967) is the best known from this area. It includes 5 species (1 *Bibio*, 4 *Dilophus*). Only one species of the family has been mentioned till now from the Arabian peninsula, *Dilophus erythraeus* Bezzi, recorded from Yemen by Duda (1930) and Hardy (1951).

The following species is the first Bibionidae to be recorded from Saudi Arabia.

### ***Dilophus tridentatus*** Walker, 1848

*Dilophus tridentatus* Walker, 1848. – List Dipt. Brit. Mus. *1:* 118.
*Dilophus africanus* Becker, 1903. – Mitt. Zool. Mus. Berlin *2:* 79.
*Dilophus africanus* Becker. – Duda 1930; Fliegen pal. Reg. *2* (1), 4: 25, figs 7–8 (redesc.).
*Philia tridentata* (Walker). – Hardy 1956; J. Kansas ent. Soc. *29:* 88 (redesc.).
*Dilophus africanus* Becker. – Baez 1984; Vieraea *13:* 106, fig. 8 (redesc.).

Material: Riyadh, 13.II.1978, 1♂ 1♀, A. S. Talhouk; Wadi Majarish, 21°19'N 40°13'E, 1020 m, 7.II.1980, 1♀, W. Büttiker, NHMB. New for Saudi Arabia.

*D. tridentatus* has been described from Lybia (Tripoli) but was not recognized until HARDY (1956) examined the type and concluded that it was a senior synonym of *africanus* Becker, a species described from Egypt (Luxor). *Tridentatus* is easily recognizable by the following combination of characters: rostrum elongated; 3 sets of spines on fore tibiae, with upper and middle sets each of 2 spines; halteres white; hind metatarsi of male not swollen. DUDA (1930) figured male head and hind leg and BAEZ (1984) fore leg of *africanus*, but the male hypopygium (which is of great specific value in *Dilophus)* has not yet been figured. It is very distinctive as can be seen in fig. 1: 9th tergum and sternum and gonocoxites fused in a basal ring; gonostyli large, elongate, with a baso-dorsal long-pilose swelling. The male hypopygium shown in fig. 17 of plate 17 in LUNDSTRÖM (1913) as *tenuis ?* Meigen from Tunis apparently belongs to *tridentatus* while *tenuis* is a completely different species.

Apart from Lybia and Egypt, *D. tridentatus* has also been recorded (partly under the junior synonym) from Tunisia (DUDA 1930), Iraq (HARDY 1956) and Canary Islands (BAEZ 1984), and I have seen material of this species from esparto-grass *(Stipa tenacissima)* steppes south of Tlemcen, Algeria (leg. Krelil, author's collection in Neuchâtel), where it is also a new record. Data are still very scarce but it appears, however, that *tridentatus* has a wide South Palaearctic distribution, extending from the Canary Islands over North Africa to the Middle East (Iraq and Saudi Arabia). It may also extend more eastwards but no data are available presently.

## Discussion of Bibionidae

Though doubtless not very rich in species, the fauna of the Arabian peninsula should probably include some of the few species recorded from neighbouring countries. So little is presently known of this fauna that one cannot draw any conclusions. It is nevertheless interesting to note that in Bibionidae – as in many other groups – this fauna shows a double affinity. The Ethiopian element is present in the south western regions with *D. erythraeus* Bezzi recorded from Sana'a area, Yemen. This species has a wide distribution in eastern Africa extending from South Africa over the East African highlands and mountains (1000–3500 m) as far north as Darfur (Sudan), Eritrea (Ethiopia) and Yemen (HARDY 1951). HARDY(1960) assumed that this species could also occur in the western part of Saudi Arabia but, though probable, this has not yet been proved.

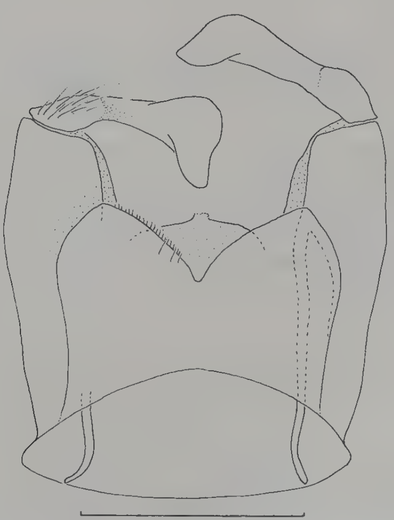

Fig. 1: *Dilophus tridentatus* Walker (Riyadh): male hypopygium, dorsal view (scale 0,5 mm).

The Palaearctic element could occur in the rest of the peninsula, i.e. in most parts of Saudi Arabia, with *D. tridentatus* and possibly other south Palaearctic species, mainly those listed from Egypt by Steyskal & El-Bialy (1967).

On the other hand no Oriental influence has yet been established.

## Fam. **Scatopsidae**

Records of Scatopsidae from the Middle East are extremely scarce while the Arabian peninsula as a whole is truly a terra incognita for this family. The present material contained only one well known species, which is nevertheless the first representative of the family for Saudi Arabia.

***Swammerdamella brevicornis*** (Meigen, 1830)

*Scatopse brevicornis* Meigen, 1830. – Syst. Beschr. *6:* 314.

*Scatopse brevicornis* Meigen. – Duda 1928; Fliegen pal. Reg *2* (5): 15, figs 5, 6, pl. III fig. 23.

*Swammerdamella brevicornis* (Meigen). – Cook 1956; Ann. Ent. Soc. Am. *49:* 17, figs 1B, 2B, 4A, 5A, 6D.

*Swammerdamella brevicornis* (Meigen). – Cook 1972; J. nat. Hist. *6:* 628, figs 1-5.

Material: Saudi Arabia: Riyadh, 2.XII.1978, 1♂, A.S. Talhouk; Hofuf, 21.IV.1976, 9♂♂ 4♀♀, A.S. Talhouk. NHMB. New for Saudi Arabia.

*S. brevicornis* is one of the most common Palaearctic Scatopsidae. It is widespread over all Europe and has also been recorded from the Canary Islands and North Africa (Egypt) by Cook (1972), and from Soviet Central Asia (URSS: Kazakhstan) by Krivosheina (1969). Nothing is known about the immature stages of this species or of any other *Swammerdamella,* but there are indications that *S. brevicornis* sometimes occurs in anthropogenic conditions.

Only two other species of Scatopsidae have previously been recorded from the Middle East: the very common cosmopolitan and anthropophilous *Coboldia fuscipes* (Meigen) from Palestine (Cook, in litt.) and the only Palaearctic species of *Psectrosciara, P. brevistylis* Cook (Cook 1958) from Iran.

There is no doubt that future collection in this part of the world will produce several other Scatopsidae. In particular one can expect that Saudia Arabia will very probably have representatives of *Psectrosciara,* a genus whose species show an almost worldwide preference for arid or semi-arid habitats.

## ACKNOWLEDGEMENTS

It gives me great pleasure to thank my friend Dr. Michel Brancucci, Naturhistorisches Museum Basel, for allowing me to study this material. I extend my thanks to Prof. Edwin F. Cook, University of Minnesota, St. Paul and Dr. D. Elmo Hardy, University of Hawaii, Honolulu, for checking faunistical records, and to Dr. George C. Steyskal, U. S. National Museum, Washington, for his kind help in providing literature.

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# Wasps of the Family Eumenidae (Hymenoptera: Vespoidea) of the Arabian Peninsula

**K. M. Guichard**

Abstract: The eumenid fauna of the Arabian peninsula is listed and at present comprises seventy-six distinct species. A single illustrated key to all the species is given. Many records are new for Arabia and five new species are described: *Labochilus felix*, *Pseudonortonia tilkiani*, *Pseudonortonia bicarinatus*, *Tricariodynerus arabicus* and *Euodynerus soikai*. *Pareumenes mimus* Giordani Soika is synonymized with *Pareumenes enslini* (Schulthess). Biogeographical affinites are briefly touched upon.

Keywords: Hymenoptera, Eumenidae, Arabian peninsula, taxonomy.

دبابير عائلة Eumenidae (غشائية الأجنحة Vespoidea)
الموجودة في شبه الجزيرة العربية
ك . غيشارد

خلاصة : أعدت قائمة بأنواع دبابير عائلة Eumenidae المعروفة في شبه الجزيرة العربية حيث تحتوي هذه القائمة على أربعة وسبعون نوعا مختلفا ، وبسبب انعدام العينات ، فان هناك انواع لا يزال وضعها التصنيفي غير مؤكد . ومع بعض الايضاحات ، تم اعطاء مفتاح تصنيفي لجميع هذه الانواع ، ولكنه تم حذف المفتاح التصنيفي لأجناس بسبب الوضع التصنيفي الغير أكيد لبعض الأجناس حيث أن مميزات الأجناس تكون في بعض الأحيان غامضة ، وهناك عدد من التسجيلات الجديدة للجزيرة العربية بالاضافة الى وصف ٤ أنواع جديدة وهي: Labochilus felix n. sp. و Pseudonortonia tilkiani n. sp. و Pseudonortonia bicarinatus n. sp. و Tricariodynerus arabicus n. sp. ولقد وجد على ان النوع Delta lepeleterii Saussure مرادفا للنوع Delta asina mixtum Soika وكذلك النوع Pareumenes mimus Soika مرادفا للنوع Pareumenes enslini (Schulthess) . وبسبب قلة العينات المجموعة ومساحة شبه الجزيرة العربية الهائلة التي تبقى حشراتها غير معروفة ، فقد تم اعطاء تفسير سطحي للعلاقات الجغرافية البيولوجية بين هذه الأنواع . ومن هذه الدراسة ، لوحظت الحاجة الماسة الى جمع عينات في المستقبل خاصة من منطقة مرتفعات تهامة وعسير ومن شمال الحجاز .

The solitary wasps of the family Eumenidae, recognized by the wings longitudinally folded in repose, are well distributed throughout the Afro-Asian (Eremian) arid belt and the Arabian Peninsula is no exception.

In Arabia, the eumenids have never been the prime subjects for collecting, until the author made specialized collections of them in Oman, March–April 1976 and September–October 1977, and in Saudi Arabia, March–April 1980 and late January–February 1983. Nevertheless, prior to 1976 in the course of general or casual collecting odd specimens of wasps including eumenids eventually found their way into the British Museum of Natural History as the result of captures by Colonel J.W. Yerbury (1895), Captain C.G. Nurse (1895), reported on by C.T. Bingham (1898), C. Rathjens (1937), H. Scott and E.B. Britton (1937–8), P.W. Petrie (1940) and D.V. Fitzgerald (1944–6).

During recent years, Swiss expeditions (Prof. W. Büttiker and Dr. W. Wittmer) have contributed a good number of specimens. Prof. A.S.Talhouk and his assistant Mr. Sarco Tilkian of the Department of Agriculture, Riyadh, have made a number of interesting captures. Mr. Giles Roche has provided most of the records from the United Arab Emirates without which an important distribution gap would have occurred. Finally, unusual but isolated records provided by J.N.B. Brown and A.R. Pittaway inspire a regret that more hymenoptera were not collected by them in remote localities.

The first paper to deal exclusively with Arabian eumenids was that of GIORDANI SOIKA(1957) where he enumerated twenty-four species of which three were described as new. The author's Oman material was dealt with by SOIKA in 1979 and 1981 and added twelve previously undescribed species to the list. The present paper enumerates seventy-six distinct species adding five previously undescribed ones.

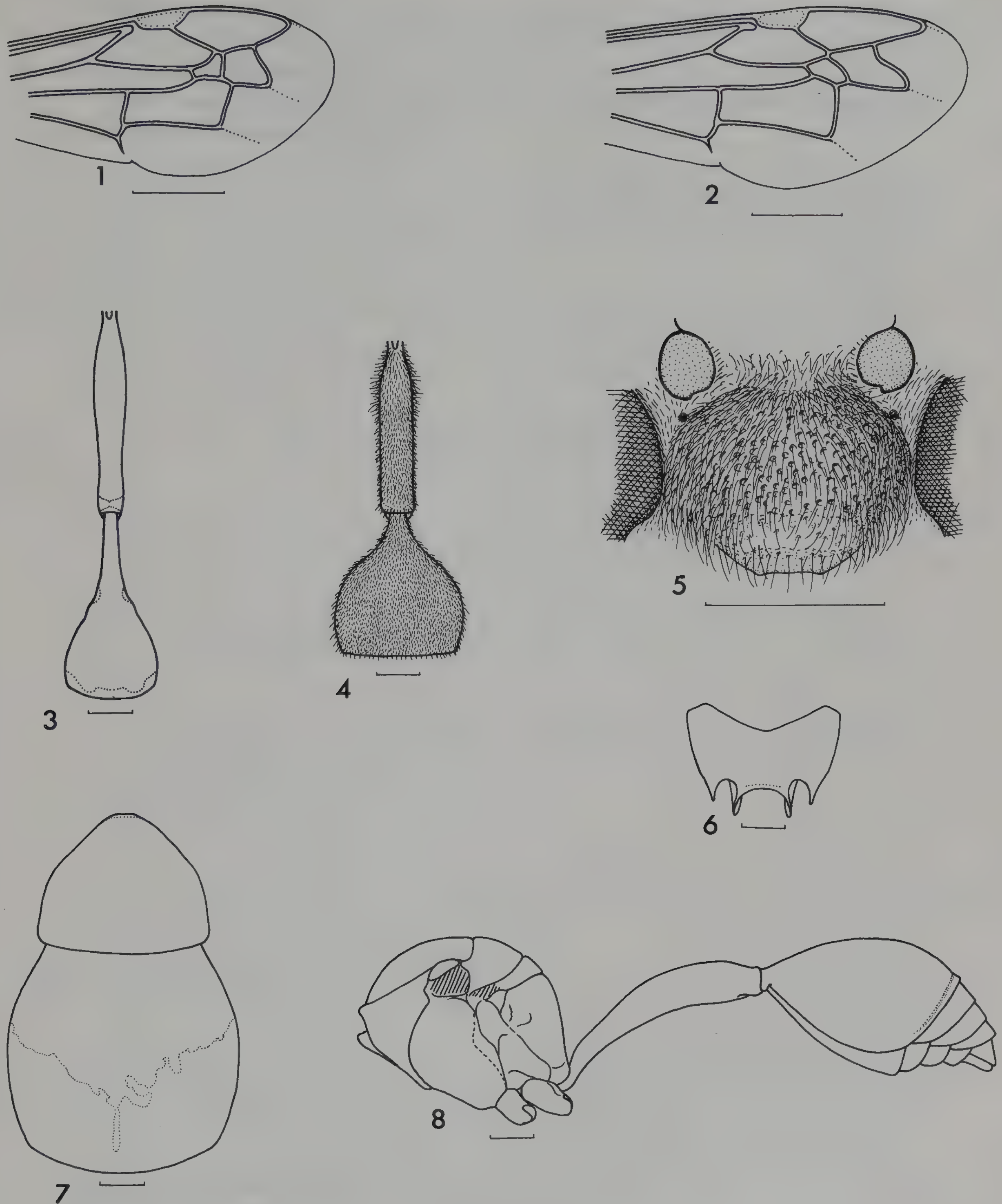
Depository of holotypes is BMNH.

Abbreviations: BMNH = British Museum (Natural History), London.
KMG = K. M. Guichard.
UAE = United Arab Emirates.

## Key to the Arabian Eumenidae

1. Forewing with first recurrent nervure ending in second submarginal cell and second recurrent nervure ending in third submarginal cell (fig. 1) (Subfamily Raphiglossinae) . 2
– Forewing with both recurrent nervures ending in second submarginal cell (fig. 2) ... 3
2. First tergite bell-shaped, not longer than wide, not much narrower than second tergite ***Psiliglossa***
– First tergite pear-shaped, much longer than apical width and much narrower than second tergite ***Raphiglossa***
3. Middle tibiae with two apical spurs (Subfamily Discoelinae) .................... 4
– Middle tibiae with only one apical spur (Subfamily Eumeninae) ................ 5
4. T1 consisting of a long slender petiole continued as such onto the basal part of T2 (fig. 3). Abdomen smooth. Tegulae pale and narrow. Male with last two antennal segments deformed ***Paramischocyttarus subtilis*** Magretti
– T1 long and slender but not continued as a petiole onto T2 (fig. 4). Whole insect covered with stiff white pubescence. Tegulae dark and angulate. Male with last antennal segment in the form of a pale hook. Clypeus (fig. 5) ***Zethus flavillaceus*** (Walker)
5. Forewing with second submarginal cell petiolated *(Alastor)* ..................... 6
– Forewing with second submarginal cell not petiolated .......................... 8
6. No red on abdomen. Black and pale yellow species. Pale clypeus in both sexes about as wide as long ***Alastor schwarzi*** Gusenleitner
– Abdomen partly red, if only on T1. Clypeus clearly much wider than long ........ 7
7. Cheeks in profile angulate. Mesopleurae with inconspicuous silvery pubescence. Only T1 red (always?) ***Alastor dalyi*** Giordani Soika
– Cheeks in profile rounded. Mesopleurae with conspicuous silvery pubescence. Red on T1 and T2 (always?) ***Alastor arabicus*** Giordani Soika
8. Large ferruginous species with smoky wings with faint violet reflections. Propodeum developed post-laterally into a prominent tooth bordering a deep emargination (fig. 6). T1 narrow and elongate and wider apically, much narrower than T2 but about equal in length. Scutellum rather flat and distinctly more shining than dull mesonotum ***Pareumenes sansibaricus arabicus*** Giordani Soika

– Without the above combination of characters. If the propodeum is developed post-laterally into a tooth or point, the species is either small or predominantly black, or with clear wings or T1 is somewhat longer than T2 or there is a combination of these characters ........ 9
9. A large species with dark wings with faint violet reflections. T1 bell-shaped and considerably narrower than T2 (fig. 7). Thorax and abdomen in male ferruginous, also in female but sometimes T2–3 yellow. Clypeus in both sexes yellow and with a yellow mark between the antennal sockets reaching up to or nearly up to the anterior ocellus. Punctuation on T2 obscure, fine, shallow and sparse ....... ***Pareumenes enslini*** (Schulthess)
– Without the above combination of characters ........ 10
10. T1 long and narrow, its apical width less than half the maximum width of T2. Length of T1 much greater than twice its width ........ 11
– T1 wider and shorter, usually only a little narrower than T2 and never longer than twice its apical width ........ 28
11. Apical margin of T2 with a narrow lamella at a lower level ........ 12
– Apical margin of T2 simple ........ 16
12. A larger blackish species, wings dark with violet reflections. Thorax in profile continuously rounded like a football (fig. 8). (Lamella on T2 impunctuate and lightly impressed. Dark ferruginous clypeus nearly twice as long as wide) ***Afreumenes nigrorufus*** Giordani Soika
– Wings clear and thorax uneven in profile ........ 13
13. Larger (10–15 mm) black and yellow species with conspicuous pubescence on thorax. T2 in profile slightly incurved before apex and lamella without well defined opaque ridges ***Eumenes mediterraneus*** Kriechbaumer
– Smaller species (6–9 mm) with only short pubescence on thorax. Lamella of T2 with opaque ridges and translucent intervals ........ 14
14. Marginal cell infuscate. Mesopleurae with inconspicuous semi-erect silver pubescence. (Clypeus black, rather shining and strongly punctuate with micro-punctuation between the punctures, the apical area strongly emarginate between prominent points) ***Micreumenes arabicus*** Guordani Soika
– Marginal cell clear. Mesopleurae with conspicuous decumbent silver pubescence ..... 15
15. Dorsal area of propodeum triangular. T1 black, ridged and pitted, reticulate-rugose, subparallel-sided. (Male antennal hook long, very narrow and curved towards tip) ***Cyrtolabulus spinithorax*** Giordani Soika
– Dorsal area of propodeum rounded. T1 red, sparsely punctuate and moderately shining, about as long as T2 and apically about twice the basal width. Postscutellum emarginate ***Cyrtolabulus gracilis*** (Kohl)
16. Temple seen from above developed, almost as wide as superior lobe of the eye (fig. 9). Clypeus rounded to truncate ........ 17
– Temple seen from above much narrower than superior lobe of eye. Apex of clypeus emarginate ........ 20
17. All-black species including wings ***Katamenes niger*** (Brullé)
– Ferruginous species with black markings ........ 18
18. Stigma black. Male metatarsus 2 short, somewhat flattened and slightly curved. (Male antennal hook dark and keeled) ***Katamenes jenjouristei*** Kostylev
– Stigma orange. Male metatarsus 2 thin and cylindrical, longer ........ 19




Figs 1–8: 1, *Psiliglossa*, forewing; 2, *Alastor dalyi*, forewing; 3, *Paramischocyttarus subtilis*, T1–2; 4, *Zethus flavillaceus*, T1–2; 5, *Zethus flavillaceus*, clypeus; 6, *Pareumenes sansibaricus*, propodeum; 7, *Pareumenes enslini* ♀, T1–2; 8, *Afreumenes nigrorufus* ♀, lateral view. (Scale-line: 1 mm).

19. Pubescence on top of head and thorax obvious, length about twice the diameter of anterior ocellus. Apical half of T1 centrally impressed
**_Katamenes sicheli coranicus_** Giordani Soika

– Pubescence on top of head and thorax microscopic. T1 simple, narrower
**_Katamenes rauensis_** Giordani Soika

20. T1 very long and narrow, parallel-sided for the apical two-thirds, somewhat flattened dorsally (fig. 10) *(Ischnogasteroides)* .......... 21

– T1 more or less gradually expanded from base to apex *(Delta)* .......... 22

21. Tegulae yellow, about twice as long as wide. Mesonotum of female without two longitudinal carinae **_Ischnogasteroides tenuissimus_** Giordani Soika

– Tegulae ferruginous, more rounded and turned down exteriorly. Mesonotum of female with two longitudinal carinae **_Ischnogasteroides leptogaster_** (Walker)

22. Wings black. Whole insect blackish, about 30 mm (very large common species)
**_Delta emarginatum_** (Linnaeus)

– Forewings partly yellowish, remainder more or less infuscate .......... 23

23. Brown and black species, at most a narrow yellow apical band on T2 .......... 24

– Species marked prominently with yellow .......... 25

24. T1 long and narrow, gradually expanding from base to apex, impunctuate or nearly so. Narrow complete or broken yellow apical band on T2 which is sometimes absent
**_Delta hottentottum elegans_** (Saussure)

– Stout build. T1 in apical half more expanded and punctuate at least laterally. No yellow on T2 **_Delta dimidiatipenne_** (Saussure)

25. A dark ferruginous species with reduced but characteristic pale yellow markings. Anterior margin of forewing yellowish up to and including the stigma. Both sexes with narrow yellow line on the front margin of pronotum. Apical part of T1 with yellow lateral patches divided by the red ground. Male antennal hook very long and curved at tip (fig. 11)
**_Delta fenestrale_** (Saussure)

– Species yellow-marked otherwise, normally with pronounced abdominal yellow colour and with black and/or red markings .......... 26

26. T1 widely expanded in apical half, strongly and unevenly punctuate, without yellow except sometimes a narrow yellow apical margin. Thorax, except pronotum in male, devoid of yellow markings. 16–26 mm. (Male antennal hook without microscopic hairs on underside) **_Delta unguiculatum_** (Villers)

– T1 more evenly expanded from base to apex, punctuation feeble or absent, apex yellow-marked. Thorax strongly yellow-marked .......... 27

27. Black on T2 a simple band. Male with mid-femora viewed somewhat from in front widely and shallowly excavated. Male antennal hook long, sinuate and curved downwards apically, with microscopic hairs on the underside laterally and with a few very small but distinct scattered bristles on the undersides of segments 7–12 of antennae (fig. 12)
**_Delta campaniforme gracile_** Saussure

– Black on T2 in the form of a cross. Male with mid-femora simple. Antennal hook shorter and straighter, more pointed and never with microscopic hairs on the underside laterally – quite naked (fig. 13). Antennal segments 7–12 beneath bare except occasionally with an isolated small bristle on segments 10–12 **_Delta asina mixtum_** Giordani Soika

28. Tegulae small and rounded, with no posterior lobe (fig. 14). Male with last segments of antennae in the form of a spiral (fig. 19a) .......... 29

– Tegulae larger, with the posterior lobe well developed (fig. 15). Male with last segments of the antennae bent in a crochet (fig. 16) .................................... 32

29. Labial palpi with three segments, the second and third in both sexes bordered with long spectacular bristles, in the female these segments flattened (fig. 17). Sternites of male with central apical brush (fig. 18) *(Pterocheilus)* .................................... 30

– Labial palpi with four unadorned segments, the last one very small (fig. 19). Last antennal segment of male twisted, elongate and shining beneath (fig. 19a). Scape of antennae orange above, yellow beneath **Paravespa mimetica** (Schulthess)

30. Large (15 mm+) straw-coloured species **Pterocheilus fausti** Morawitz

– Smaller species up to 10 mm .................................... 31

31. In both sexes apical margin of clypeus much wider than space between antennal insertions, in female apical margin truncate (fig. 20), in male widely emarginate. In both sexes propodeum with longish outstanding white pubescence. Last antennal segment of male black **Pterocheilus chobauti calefactus** Giordani Soika

– Apical margin of clypeus in female lightly emarginate and nearly as wide as space between antennal insertions (fig. 21). Dorsal face of propodeum naked. (A mainly straw-coloured species with black vertical marks on thorax and a small transverse black band on central part of T1 and T2) **Pterocheilus arabicus** Giordani Soika

32. T2 furnished at the apex with a translucent lamella at a lower level than the rest of the tergite and with more or less developed opaque ridges between clear intervals ....... 33

– T2 without a translucent lamella although in that area it may be depressed and punctuate. (*Pseudodontodynerus* has a small lamella, but in that case T2 is longitudinally ridged in the centre) .................................... 39

33. Labial palpi on both sides with long curved bristles similar to but less exaggerated than in *Pterocheilus*. Tongue long (fig. 22), head in dorsal view quadrate, tegulae rounded, T1 and legs entirely or partly red. Size small, 6–7 mm .................................... 34

– Labial palpi simple or at most with a few bristles on basal segment .............. 35

34. Postscutellum widely rounded. Clypeus with large and small punctuation and apical margin widely and shallowly emarginate (fig. 42) ♀ **Labochilus pulawskyi soharensis** Giordani Soika

– Postscutellum emarginate. Clypeus with only large punctuation, the produced part of apical margin straight or almost so (fig. 43) ♀ **Labochilus felix** n. sp.

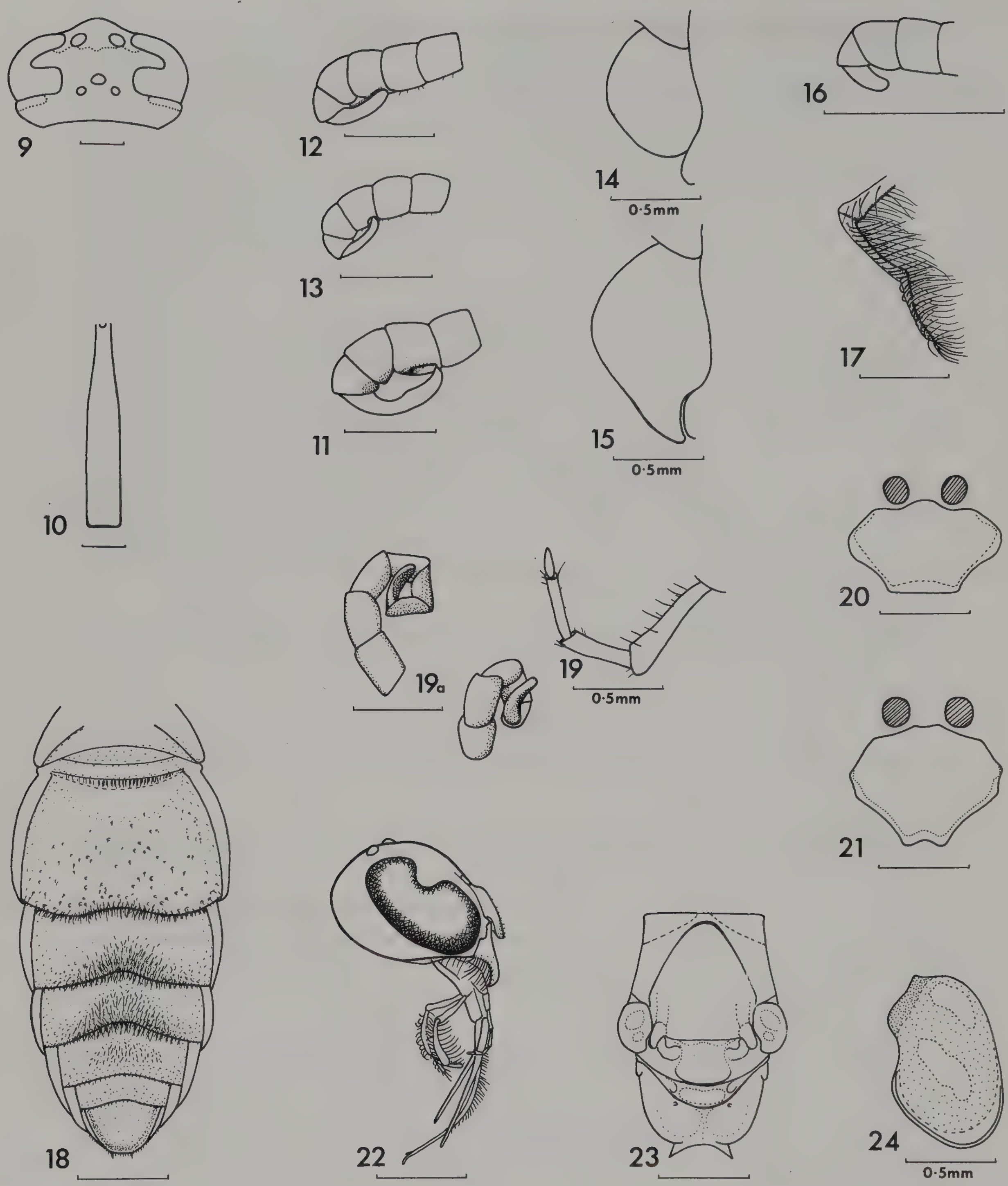
35. Form elongate. Seen from above, length of thorax much greater than twice its width at the pronotum (fig. 23). T1 more or less parallel-sided in the apical third. Tegulae posteriorly narrowing more or less to a point. Clypeus flattened (fig. 41). Small species 6–7.5 mm **Leptodynerus arabicus** Giordani Soika

– Form not elongate. Seen from above length of thorax little more than twice its width at pronotum. T1 regularly expanding from base to apex. Tegulae either rounded or merely angled posteriorly .................................... 36

36. Larger species, 10–12 mm. Tegulae elongate and completely rounded at apex (fig. 24) (Subgenus *Euleptochilus*) .................................... 37

– Smaller species, 6–7 mm. Tegulae rounded but angled posteriorly ................ 38

37. Tegulae ferruginous. Apical emargination of clypeus clearly less than distance between eye sockets. Front margin of pronotum somewhat sinuate with lateral points ♀ **Leptochilus ayunensis** Giordani Soika




Figs 9–24: 9, *Katamenes jenjouristei,* dorsal view of head; 10, *Ischnogasteroides,* T1; 11, *Delta fenestrale,* ♂ antennal hook; 12, *Delta campaniforme gracile,* ♂ antennal hook; 13, *Delta asina mixtum,* ♂ antennal hook; 14, *Pterocheilus arabicus* ♀, tegula; 15, *Ancistrocerus phaleratus* ♀, tegula; 16, *Euodynerus sulfuripes* ♂, last antennal segments; 17, *Pterocheilus chobauti calefactus* ♀, labial palpi; 18, *Pterocheilus arabicus* ♂, sternites with apical brush; 19, *Paravespa mimetica,* labial palpi; 19a, *Paravespa mimetica* ♂, last antennal segments (two views); 20, *Pterocheilus chobauti calefactus* ♀, clypeus; 21, *Pterocheilus arabicus* ♀, clypeus; 22, *Labochilus* ♀, head including mouth parts, lateral view; 23, *Leptodynerus arabicus,* thorax; 24, *Leptochilus muscatensis* ♀, tegula. (Scale-line: 1 mm).

– Tegulae straw-coloured, partly translucent (fig. 24). Apical emargination of clypeus about equal to the distance between eye sockets. Pronotum laterally not forming prominent points ♀ ***Leptochilus muscatensis*** Giordani Soika

38. Front of pronotum sinuate. Female with lateral angles of clypeal emargination rounded and slightly upturned. Upper side of male antennal hook gently curved, the hook deeply embedded in the corresponding segment ***Cyrtolabulus exiguus*** (Saussure)

– Front of pronotum straight. Female clypeus apically with short carina at the lateral angles of the emargination and closely punctuate between them. In profile, upper side of male antennal hook sinuate ***Leptochilus medanae*** Gribodo

39. Viewed dorsally, T1 much narrower than T2; apical width of T1 usually only about one third of apical width of T2 ........ 40

– Viewed dorsally, lateral margins of T1 and T2 contiguous ........ 45

40. T1 with two carinae (fig. 25), one basal and the other more or less central, the space between them dull and impunctuate except at the base. (Black and white species with white apical bands on T1 and T2, white tibiae and metatarsi, pronotum white-marked, clypeus and tegulae white with black centres) ***Pseudonortonia bicarinatus*** n. sp.

– T1 with only one basal carina (figs 26 & 27) ........ 41

41. T1 red. (T1 viewed dorsally with outstanding white lateral hairs (fig. 26). Base of T1 behind the carina shining and with some large ill-defined punctures or pits) ***Pseudonortonia omanensis*** Giordani Soika

– T1 black ........ 42

42. T1 laterally with outstanding white hairs (fig. 26). (In female extensive ferruginous markings on jaws, underside of antennae, clypeus, thorax, tegulae, coxae and most of legs and tip of abdomen) ***Pseudonortonia aberratica arabica*** Giordani Soika

– T1 laterally without outstanding white hairs (fig. 27) ........ 43

43. Apex of T1 only a little wider than scutellum. (In both sexes T2 expanding abruptly after T1. Some ferruginous on jaws distally, otherwise without ferruginous markings. Tegulae white with dark centres; front and mid-tibiae mostly white. T3 strongly punctuate right across segment) ***Pseudonortonia tilkiani*** n. sp.

– Apex of T1 much wider than scutellum ........ 44

44. Most of scape, clypeus, front of pronotum, tegulae and T4–6 reddish. Legs dark. Viewed dorsally contours of T1 and T2 almost contiguous ***Pseudonortonia scotti*** Giordani Soika

– Except on jaws, no reddish markings (at least in Arabian specimens). Viewed dorsally, T2 expanding somewhat abruptly after T1. (T3 centrally with a patch of very large close punctures and with weak punctuation laterally. Male antennal hook broad and twisted) ***Pseudonortonia difformis*** (Saussure)

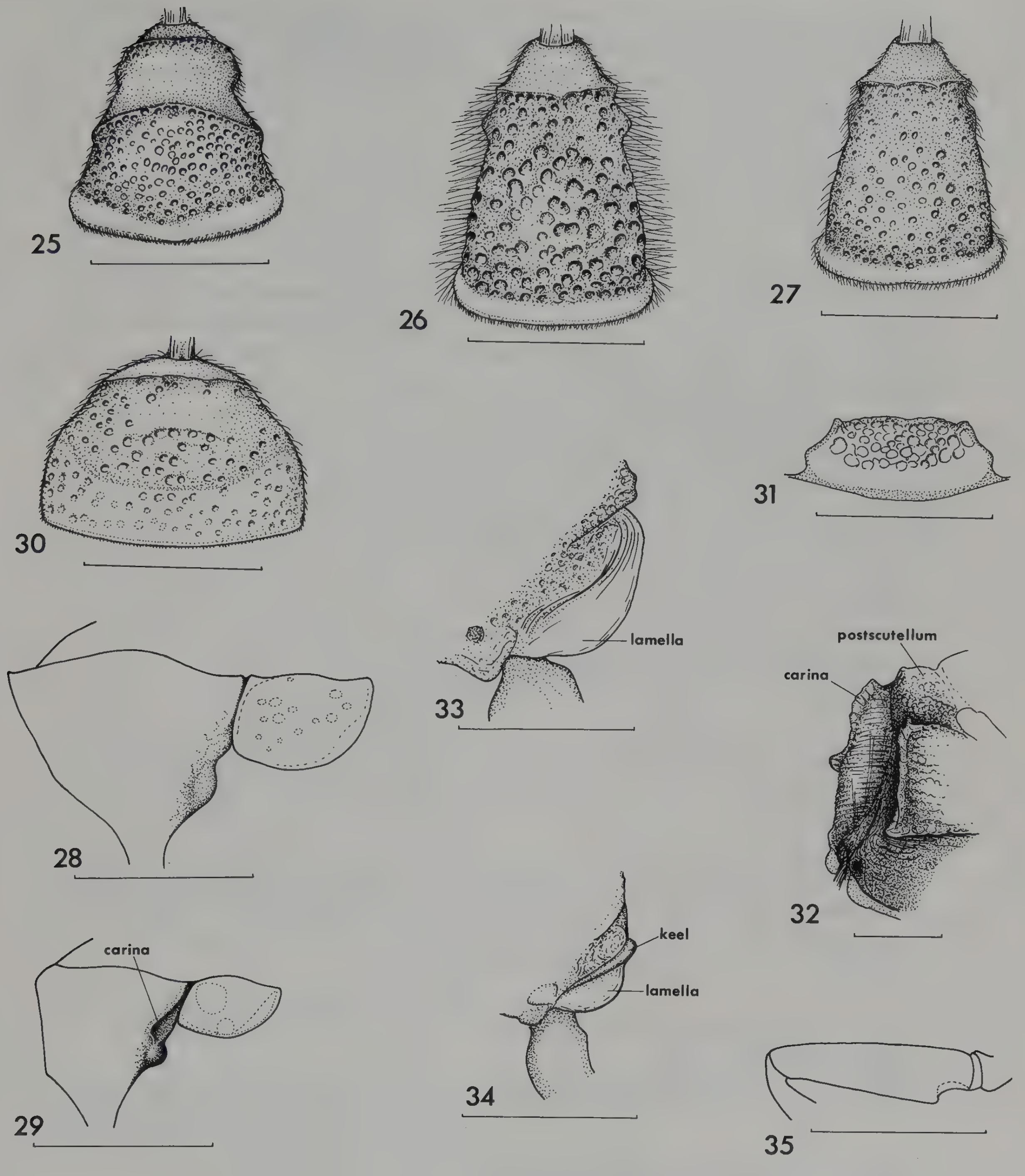
45. No carina in front of tegulae and tubercle in front of pronotum feebly developed, never convex and shining (fig. 28) ........ 46

– A small carina in front of tegulae and tubercle of pronotum always developed, often convex and shining (fig. 29) ........ 47

46. Carina at base of T1 more or less gently curved in a wide arc each side of the middle. Tegulae strongly punctuate. Female clypeus transverse, about twice as wide as long. Male antennal hook broad and truncate. In both sexes abdomen partly whitish ***Eustenancistrocerus inconstans*** (Saussure)

– Carina at base of T1 of variable and irregular shape. Tegulae weakly punctuate. Female clypeus not twice as wide as long. Male antennal hook relatively narrow and somewhat rounded at tip. Abdomen black and yellow
***Eustenancistrocerus amadanensis*** (Saussure)

47. T1 with transverse carina at base (fig. 30) .......... 48
– T1 without transverse carina at base .......... 51
48. T1 with smooth impunctuate area behind the basal carina. Tegulae with more rounded lobes .......... 49
– T1 punctuate behind basal carina. Tegulae more elongate, the posterior lobes more pointed .......... 50
49. Smaller black and white species. Front margin of pronotum thickened each side of middle, sinuate. Male antennal hook thick, especially at base, strongly curved
***Tachyancistrocerus serenus*** Giordani Soika
– Larger species with T1 and propodeum red-marked. Front margin of pronotum normal. Male antennal hook parallel-sided and gently curved
***Tachyancistrocerus qabosi*** Giordani Soika
50 A predominantly orange species ***Ancistrocerus adenensis*** Giordani Soika
– Black with red legs and yellow abdominal bands. (Top of head, thorax and T1 with abundant long reddish hairs. S2 not angled after the sulcature and almost level in profile)
***Ancistrocerus phaleratus palaestinicus*** Giordani Soika
51. Postscutellum bidentate, a more or less outstanding tooth or projection on each side (fig. 31) .......... 52
– Postscutellum not bidentate .......... 58
52. Wings black. A very large black species 25–30 mm with tip of abdomen orange. Jaws exceptionally long, those of male deformed and excavated. No ridges on mesonotum
***Synagris spiniventris*** (Illiger)
– Wings seldom black. Smaller species. Jaws normal .......... 53
53. T2 longitudinally ridged in centre. Propodeum post-laterally with a large excavated process. Postscutellum with prominent teeth. Whole insect red
***Pseudodontodynerus brittoni*** Giordani Soika
– T2 not ridged. Propodeum post-laterally without large excavated process .......... 54
54. An orange-brown and black species. (In both sexes pronotum, scutellum, postscutellum, two large spots on propodeum, T1 except base, T2 except central area and legs orange-brown. Male with jaws, clypeus and parts of face yellow)
***Antepipona yemenensis*** Giordani Soika
– Black and white or black and yellow species .......... 55
55. Black and white species. (Tegulae red and strongly punctuate. Male antennal hook very small and obscure) ***Antepipona kassalensis*** Giordani Soika
– Black and yellow species .......... 56
56. A smooth black shining area with a few shallow punctures on each side of propodeum. Tegulae shining and impunctuate. Vertical face of postscutellum strongly shining
***Antepipona arabica*** Giordani Soika
– Without black shining area on each side of propodeum .......... 57
57. Tegulae broadly rounded. Lateral yellow mark on T2
***Antepipona omanensis*** Giordani Soika




Figs 25–35: 25, *Pseudonortonia bicarinatus* ♀, T1 with two carinae; 26, *Pseudonortonia aberratica arabica* ♀, T1; 27, *Pseudonortonia tilkiani*, T1; 28, *Eustenancistrocerus inconstans*, no carina in front of tegula; 29, *Tachyancistrocerus serenus*, carina in front of tegula; 30, *Tachyancistrocerus serenus*, T1 with carina at base; 31, *Antepipona yemenensis*, bidentate postscutellum; 32, *Euodynerus excellens*, part of propodeum, rear view; 33, *Chlorodynerus*, valve of propodeum; 34, *Euodynerus*, valve of propodeum; 35, *Xanthodynerus octavus*, mid-femur ♂. (Scale-line: 1 mm).

– Tegulae elongated with a slender posterior lobe. Without lateral yellow marks on T2. Sides of propodeum with large yellow patch ***Antepipona cingulifer*** (Walker)
58. Posterior part of mesonotum and scutellum smooth and shining, almost impunctuate. Wings bicoloured, flavous and smoky . . . . . . . . 59
– Mesonotum and scutellum punctuate . . . . . . . . 60
59. Female clypeus narrowly truncate at apex; male clypeus white and mid-femora deformed, widely and shallowly excavated beneath basally ***Rhynchium oculatum distinguendum*** Buysson
– Female clypeus apically shallowly emarginate with lateral points turned slightly outwards; male clypeus blunt and inwardly curved apically, ferruginous. Mid-femora almost simple ***Rhynchium cyanopterum*** (Saussure)
60. Upper carina of propodeum developed, more or less lamelliform, forming above a tooth as well as a fissure more or less narrowly separated from the postscutellum (fig. 32) . . 61
– Upper carina of propodeum slightly developed or absent . . . . . . . . 71
61. Postscutellum regularly convex. A black and white species with largely red legs and a pale apical band on T1 which is expanded in the middle with a typical short black incision there ***Syneuodynerus fouadi dhofariensis*** Giordani Soika
– Dorsal area of postscutellum separated from posterior face by a somewhat serrated edge . 62
62. The valve of the propodeum is formed by only one transparent lamella (fig. 33). Predominantly pale yellow species . . . . . . . . 63
– The valve of the propodeum is formed by a transparent lamella and an additional keel or more or less pointed process superimposed upon it (fig. 34) . . . . . . . . 64
63. Front coxae almost flat with strong lateral carinae. Male genitalia black ***Chlorodynerus chloroticus*** (Spinola)
– Front coxae convex and if longitudinal carinae are present they are more centrally placed. Male genitalia pale ***Chlorodynerus kelidopterus*** (Kohl)
64. Pale yellow or orange-brown species . . . . . . . . 65
– Coloured otherwise . . . . . . . . 66
65. Pale yellow species like a small *Chlorodynerus*. Male mid-femora angulated at base and flattened beneath (fig. 35). Tips of antennae black ***Xanthodynerus octavus*** Giordani Soika
– Larger orange-brown species. Male mid-femora simple and antennae unicolourous. (Female with small dark fosette close to hind margin of head) ***Euodynerus excellens*** (Perez)
66. Tegulae strongly and closely punctuate except for central smooth area. Wings bicoloured . 67
– Tegulae almost impunctuate . . . . . . . . 68
67. Wings yellow basally, rest smoky. Whole insect predominantly red. Antennae orange ***Euodynerus sinaiticus*** Giordani Soika
– Wings hyaline basally, rest smoky. Mesothorax black, scutellum and postscutellum red, T1 red, remainder of abdomen mostly black. Antennae black apically ***Euodynerus niloticus ebneri*** (Schulthess)
68. Tegulae red, shining and elongate. (T2 and T3 bright yellow. Wings smoky-flavous. Larger species) ***Euodynerus stigma*** (Saussure)
– Tegulae coloured otherwise . . . . . . . . 69
69. Cheeks conspicuously ridged and angulate (fig. 36). Sides of pronotum rounded. (Male antennal hook narrow and almost straight, fig. 36a) ***Euodynerus salzi*** Giordani Soika

– Cheeks only slightly ridged and much more rounded (fig. 37). Sides of pronotum more right-angled .......... 70

70. Mesonotum with yellow dot. Male antennal hook slightly curved. A yellow and red or yellow and black species ***Euodynerus sulfuripes*** Morawitz

– Mesonotum without dot. Male antennal hook broad and strongly curved (fig. 38). A black and white species with red on legs ***Euodynerus familiaris*** Giordani Soika

71. The part which unites the sides of the scutellum to the metaepisternum is very wide and there is no clearly defined circular fosette unobscured by hairs bordering the scutellum (fig. 39) .......... 72

– The part which unites the sides of the scutellum to the metaepisternum is relatively narrow leaving a clearly defined circular fosette unobscured by hairs (fig. 40) .......... 73

72. A black and yellow-banded species with the yellow band on T1 greatly expanded laterally. (Clypeus transverse, in male deeply emarginate with apical points. T1 transverse and considerably narrower than T2) ***Allodynerus dignotus*** (Morawitz)

– T2 red with a sinuate apical yellow band. (Clypeus in both sexes with the apical emargination narrow, half the width between the antennal sockets, in the female red with shallow sparse punctures, in the male yellow, dull and almost impunctuate) ***Pseudepipona multicolor dhufariensis*** Giordani Soika

73. Dark-winged species with two prominent longitudinal carinae on mesonotum. Second sternite excavated .......... 74

– No carinae on mesonotum .......... 75

74. Large, very dark species with T3 onwards orange. Postscutellum with a small central triangular keel (fig. 45). Clypeus transverse, rather finely punctuate and with prominent apical points ***Pseudepipona magretti*** (Gribodo)

– Medium-sized stout red species with only T2 yellow. Postscutellum widely emarginate with central keel obsolete. Female clypeus (fig. 44) ***Tricariodynerus arabicus*** n. sp.

75. Front of pronotum in male bidentate, in female raised. (Scape in male yellow, antennae pale orange with darker tips) ***Pseudepipona nekt*** Giordani Soika

– Front of pronotum normal. Slender deep brown and black species ♀ ***Antodynerus ignaruris*** (Kohl)

## SYSTEMATIC LIST

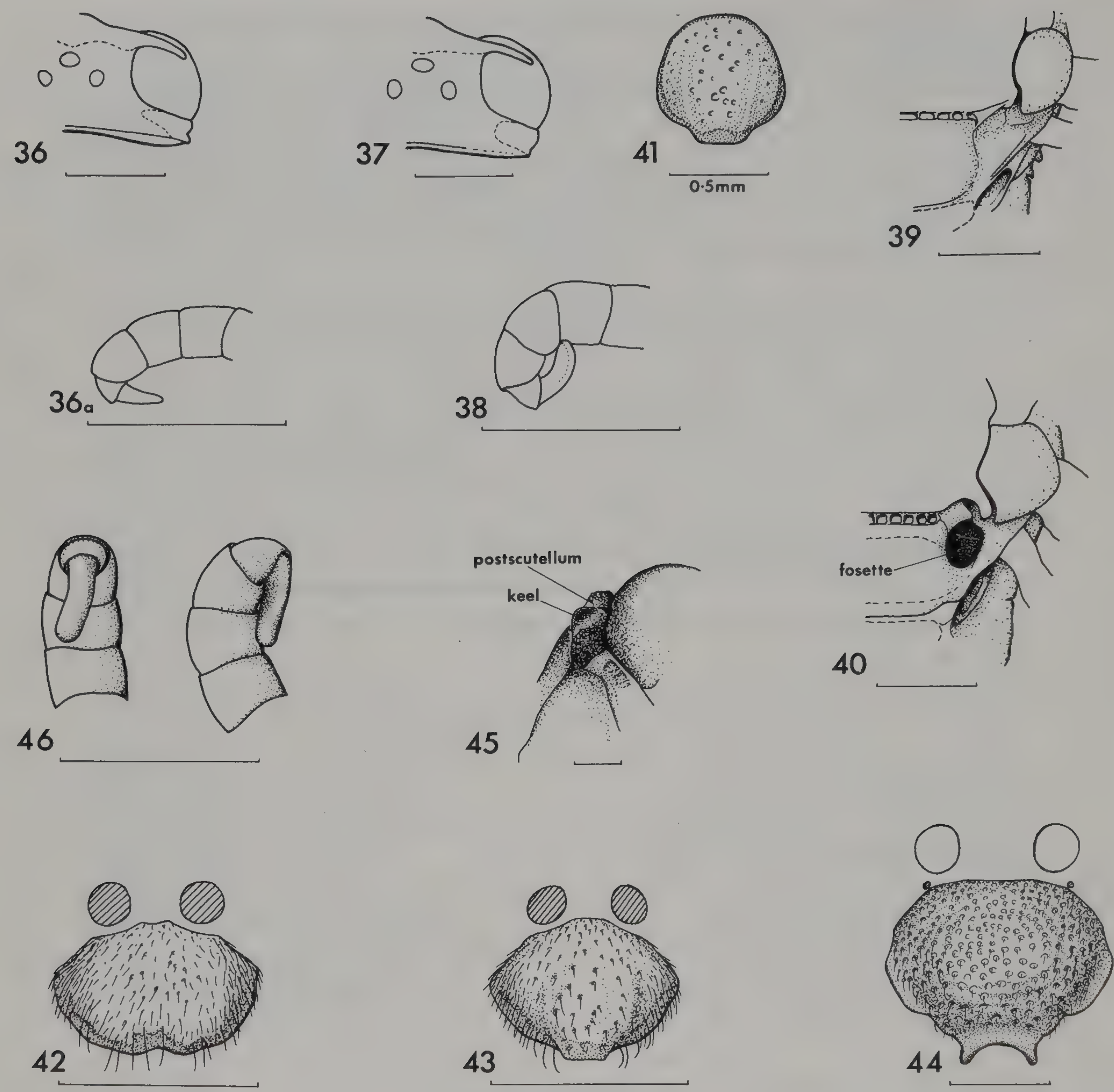
The area under consideration consists of all the Arabian peninsula south of the northern border of Saudi Arabia.

### Fam. **Eumenidae**

### Subfam. **Raphiglossinae**

***Psiliglossa*** S.S. Saunders, 1850

The only representative of this subfamily is a single small male from El Ha'ir near Riyadh, 19.III.1980, (KMG). Further material is awaited. It would be strange if the second widespread genus, *Raphiglossa* S.S. Saunders, 1850, was not also found in Arabia as it occurs in Africa north and south of the Sahara and in Palestine and Iran. Both genera are characterized by an exceptionally long tongue.




Figs 36–46: 36, *Euodynerus salzi,* cheek, dorsal view; 36a, *Euodynerus salzi,* ♂ antennal hook; 37, *Euodynerus sulfuripes,* cheek, dorsal view; 38, *Euodynerus familiaris,* last antennal segments ♂; 39, *Allodynerus dignotus,* side of scutellum etc.; 40, *Antodynerus ignaruris,* side of scutellum etc.; 41, *Leptodynerus arabicus* ♀, clypeus; 42, *Labochilus pulawskyi soharensis* ♀, clypeus; 43, *Labochilus felix* ♀, clypeus; 44, *Tricariodynerus arabicus* ♀, clypeus; 45, *Pseudepipona magretti* ♂, postscutellum; 46, *Euodynerus soikai,* ♂ antennal hook. (Scale bar: 1 mm).

## Subfam. **Discoelinae**

### ***Paramischocyttarus subtilis*** Magretti, 1884

*Paramischocyttarus subtilis* Magretti, 1884. – Boll. Soc. ent. ital. *15* (1883): 250.

Localities: Saudi Arabia: Bahra near Jeddah, II & IV (KMG). Oman: Sur, III (KMG).

Distribution: Eastern Africa south of Sahara, Palestine, Arabia.

***Zethus flavillaceus*** Walker, 1871

*Zethus flavillaceus* Walker, 1871. – List Hym. Egypt (1871): 28.

Locality: Saudi Arabia: Wadi Majarish below Taif 800 m, 12.II.83, ♀ 6 ♂♂ (KMG).

Distribution: Tropical Africa, W. Arabia.

## Subfam. **Eumeninae**

***Paravespa mimetica*** (Schulthess, 1924)

*Odynerus (Hoplopus) mimeticus* Schulthess, 1924. – Konowia *2* (1923): 284.

Locality: Saudi Arabia: Madain Salih, IV. 1946, ♂ (D.V. Fitzgerald).

Distribution: S.W. Asia, N. Arabia, Palestine – Jericho.

***Pterocheilus fausti*** Morawitz, 1873

*Pterochilus fausti* Morawitz, 1873. – Hor. Soc. ent. ross. *9:* 296.

Localities: Saudi Arabia: Madain Salih, IV. 1946, ♀ (D.V. Fitzgerald). A second female labelled "Arabia" was collected by A.R. Pittaway.

Distribution: Arabia, Negev.

***Pterocheilus arabicus*** Giordani Soika, 1970

*Pterocheilus arabicus* Giordani Soika, 1970. – Boll. Mus. civ. Stor. nat. Venezia *20/21:* 55.

Locality: Arabia: Shakkot El Irman (?), 31.I.46, ♀. Type in BMNH.

Distribution: Arabia, Baluchistan: Kharan 1000 m, X.1982, 3 ♀♀ (G. Popov).

***Pterocheilus chobauti calefactus*** Giordani Soika, 1970

*Pterocheilus chobauti* ssp. *calefactus* Giordani Soika, 1970. – Boll. Mus. civ. Stor. nat. Venezia *20/21:* 54.

Localities: Saudi Arabia: El Ha'ir near Riyadh, 17.III.80, ♂ (KMG); Riyadh, 27.IV.80, ♀ (KMG); Wadi Majarish, 12.II.83, ♀ (KMG). Oman: Rostaq and Tinaf, III.

Distribution: Palestine, Syria, Arabia.

Two male *Pterocheilus,* one from Masirah Island and the other from Kuwait, may belong to a closely allied species. Both differ from *calefactus* in the more transverse clypeus with a narrower apical emargination, the smaller bead-like last antennal segment and the lemon-yellow colour instead of orange.

***Alastor schwarzi*** Gusenleitner, 1967

*Alastor (Megalastor) schwarzi* Gusenleitner, 1967. – Polskie Pismo. ent. *37:* 667

Locality: Saudi Arabia: El Ha'ir near Riyadh, 17.III.80, 2 ♂♂ (KMG).

Distribution: Turkey and Saudi Arabia.

***Alastor dalyi*** Giordani Soika, 1979

*Alastor dalyi* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 272.

Locality: Saudi Arabia: Wadi Hanifa near Riyadh, 21.III.80, ♂ (KMG).

Distribution: An Arabian endemic described from Oman from several localities.

***Alastor arabicus*** Giordani Soika, 1979

*Alastor arabicus* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 272.

Distribution: An Arabian endemic from Dhofar, X, 2 ♀♀ (KMG). Male unknown.

**_Leptodynerus arabicus_** Giordani Soika, 1970

*Leptodynerus arabicus* Giordani Soika, 1970. – Boll. Mus. civ. Stor. nat. Venezia *20/21:* 62.

*Leptochilus (Lionotulus) arabicus.* – Giordani Soika, 1980; Boll. Mus. civ. Stor. nat. Venezia *31:* 114 (♂♂).

Localities: Saudi Arabia: El Riyadh, 3.IV.59, ♀ (Dr. Diehl, col. Linsenmaier). Oman: Sur (W. Rafsah), 17.III.76, 4 ♂♂ (KMG); Wadi Quryat, 5.III.76, ♀ (KMG).

Distribution: An Arabian endemic.

A male *Leptodynerus* from Riyadh, 17.IV.80 (KMG), differs from the Oman males (one of which bears Soika's allotype label and the other a paratype label) by the more rounded tegulae, the shorter dorsal area of the propodeum and the shape of T1. In view of the type of *Leptodynerus arabicus* coming from Riyadh, further Riyadh material is required.

**_Leptochilus muscatensis_** Giordani Soika, 1979

*Leptochilus (Euleptochilus) muscatensis* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 273.

Locality: Muscat, Ruwi, III.76, ♀ (KMG). Male unknown. Arabian endemic.

**_Leptochilus ayunensis_** Giordani Soika, 1980

*Leptochilus (Euleptochilus) ayunensis* Giordani Soika, 1980. – Boll. Mus. civ. Stor. nat. Venezia *31:* 111.

Locality: Dhofar: Ayun Pools, 10.X.77, ♀ (KMG). Arabian endemic. Male unknown.

**_Leptochilus medanae_** (Gribodo, 1886)

*Odynerus medanae* Gribodo, 1886. – André Spec. Hym. Eur. *2:* 874.

Localities: Saudi Arabia: El Ha'ir near Riyadh, 17.–19.III.80, ♀ 3 ♂♂ (KMG); Riyadh, 27.IV.80, ♂ (KMG).

Distribution: S. France, Spain, North Africa, Arabia.

**_Leptochilus masirahensis_** Giordani Soika, 1980

*Leptochilus (Neoleptochilus) masirahensis* Giordani Soika, 1980. – Boll. Mus. civ. Stor. nat. Venezia *31:* 113.

Distribution: Arabia: Masirah Island, a series, II.76 (KMG).

The only indisputable difference between these and *medanae* is the weaker punctuation, particularly on the clypeus. Probably only a form of *medanae.*

**_Labochilus pulawskyi soharensis_** Giordani Soika, 1979

*Labochilus pulawskyi* ssp. *soharensis* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30.:* 275.

Locality: Oman: Sohar, 31.III.76, ♀ (KMG).

Differs from the type form found in Egypt in punctuation and small markings on T3–5.

**_Labochilus felix_** n. sp.

Holotype: ♀, Oman (Dhofar): km 48 Salalah–Thamarit main road, 670 m, 6.X.1977, K.M. Guichard, BMNH. – Paratypes: 2 ♀♀ as holotype, in col. mea.

Holotype ♀: Clypeus transverse but not so wide as *pulawskyi,* shining with large shallow punctures. Mouth parts similar to *pulawskyi* and *linguarius* (Saunders, 1905). Temples well developed, slightly narrower than upper lobe of eye. Lateral angles of pronotum without points. Mesonotum shining, closely and strongly punctuate; scutellum less strongly punctuate. Postscutellum clearly emarginate. Dorsal face of propodeum laterally with silver pubescence of two divisions facing opposite directions, similar to *pulawskyi.* Pubescence elsewhere, except on cheeks, short and inconspicuous. Abdomen with T1 campanulate, with sparse punctuation posteriorly. T2 only moderately shining, rather closely punctuate

on a ground with a coriaceus microsculpture repeated on S2 which is more shining centrally and more closely punctuate laterally. Pale apical lamella of T2 weakly ridged.

Head black except jaws, clypeus and scape ferruginous and a tiny spot behind eye pale. Thorax black with the following parts white – front of pronotum, a round spot on mesopleurae, part tegulae, part scutellum, the triangular post-tegulae, two small lateral spots on the postscutellum, part tibiae and a spot on the apex of front femora. On the thorax there is red on the pronotum, tegulae, postscutellum and propodeum and all the femora are red.

The abdomen is red with a darker central patch on T2. T1 and T2 have white apical bands, that on T2 slightly expanded laterally. Wings clear except for infuscate marginal cell with small clear basal area and infuscation extending to tip of wing. Length 5.5 mm.

The paratypes differ somewhat in colour; the tegulae are white except for central clear spot. The darker central patch on T2 is lacking in one specimen. The clypeus and scape in both paratypes are much paler, almost straw-coloured. In one paratype most of the scutellum and all of the postscutellum are white.

*L. felix* ♀ differs clearly from the type species *L. linguarius* and *L. pulawskyi* in the emarginate postscutellum and in the shape of the clypeus. This new species was previously misidentified by me (see Soika 1980) as *Leptochilus praestans* Giordani Soika, 1970 which is not known from Arabia.

### ***Cyrtolabulus spinithorax*** Giordani Soika, 1968

*Cyrtolabus spinithorax* Giordani Soika, 1968. – Boll. Mus. civ. Stor. nat. Venezia *18:* 115.

Previously , this species was known only from a single female from the Hoggar in the Central Sahara. The Saudi Arabian male from the Wadi Majarish below Taif was taken at the flowers of an *Ochradenus* bush issuing from the top of an *Acacia* on 29.III.83 (KMG). The peculiar triangular shape of the propodeum and the elongated T1, longer than T2, makes the species unmistakable and unlike any other *Cyrtolabulus.*

In the male the clypeus, which in this specimen is centrally white, is covered with dense decumbent silver pubescence largely obscuring the surface, while the apical emargination is shallow and slightly less wide than the width between the eye sockets. The antennal hook is long, thin and moderately curved and in repose reaches the base of the eleventh segment. The tibiae are white above.

### ***Cyrtolabulus gracilis*** (Kohl, 1906)

*Labus gracilis* Kohl, 1906. – Denkschr. Akad. Wiss. Wien, Math. Naturw. Kl. *71* (1): 227.

Localities: Saudi Arabia: Riyadh, Wadi Hanifa, 16.III.80, ♂ (KMG); Riyadh, 4.II.83, ♀ (KMG). UAE: Hatta, 2 ♂♂ (G. Roche).

Distribution: Sahara, Sinai, Egypt, Palestine, Oman.

The punctuation on T2 varies considerably, being strongest in those from UAE, weakest from Jericho and intermediate from Oman.

### ***Cyrtolabulus exiguus*** (Saussure, 1853)

*Leptochilus exiguus* Saussure, 1853. – Et. Fam. Vesp. *1:* 237.

Localities: Saudi Arabia: El Ha'ir near Riyadh, 30.IV.80, ♀ (KMG); Abu Arish, 24.III.80, ♀ ♂ (KMG). The Riyadh specimen is ferruginous with reduced black markings on the mesonotum and with weaker punctuation.

Distribution: Sahara, Egypt, Palestine, Arabia.

**_Micreumenes arabicus_** Giordani Soika, 1979

*Micreumenes arabicus* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 276.

An Arabian endemic from Oman. Two females, II.–III.76 (KMG).

**_Tachyancistrocerus serenus_** (Giordani Soika, 1935)

*Ancistrocerus (Subancistrocerus) serenus* Giordani Soika, 1935. – Bull. Soc. ent. Egypte *19:* 169.

Localities: Saudi Arabia: Riyadh, III.–IV.80, 2 ♀♀ 3 ♂♂ (KMG); Riyadh, 4.XI.81, ♀ (Talhouk).

Distribution: North Africa, Palestine, Arabia.

**_Tachyancistrocerus quabosi_** Giordani Soika, 1979

*Tachyancistrocerus quabosi* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 278.

Locality: UAE: Hatta, 23.XII.81, ♀ ♂ (J.N.B. Brown).

Common in Oman. An Arabian endemic. The word "quabosi" has been spelt wrongly in the original description. It should have been "qaboosi" as it appears on the paratype labels in a compliment to His Majesty Sultan Qaboos bin Said, Sultan of Oman.

**_Eustenancistrocerus inconstans_** (Saussure, 1863)

*Odynerus (Stenancistrocerus) inconstans* Saussure, 1863. – Mem. Soc. Phys. Hist. nat. Genève *17:* 217.

Localities: Saudi Arabia: Riyadh, IV.80, 7 ♀♀ 1 ♂ (KMG); Abu Arish, I.83, 5 ♀♀ 4 ♂♂ (KMG).

Distribution: N. Africa, Palestine, Iran, Arabia including Oman and South Yemen.

**_Eustenancistrocerus amadanensis_** (Saussure, 1855)

*Odynerus (Ancistrocerus) amadanensis* Saussure, 1855. – Et. Fam. Vesp. *3:* 214.

Locality: Saudi Arabia: Hofuf, 20.IV.80, 14 ♀♀ 15 ♂♂ (KMG).

Distribution: W. Pakistan, Irak, Iran, Palestine, Turkey.

At Hofuf, both the red and black form occurred with intermediates, visiting flowers of *Zizyphus* and *Flaveria trinervia.*

**_Pseudonortonia omanensis_** Giordani Soika, 1979

*Pseudonortonia omanensis* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 279.

An Arabian endemic from Oman, Nizwa, III.76, ♂ 3 ♀♀ (KMG).

**_Pseudonortonia aberratica arabica_** Giordani Soika, 1957

*Pseudonortonia aberratica* (Morice) ssp. *arabica* Giordani Soika, 1957. – Hymenoptera; Vespidae. Expedition to South-West Arabia, 1937–8, (1) *31:* 476.

Locality: Saudi Arabia: Taif 2000 m, 8.IV.80, 2 ♀♀ (KMG).

Distribution: South Yemen. Type in BMNH. The typical form is from Egypt and Eritrea.

**_Pseudonortonia difformis_** (Saussure, 1852)

*Odynerus (Ancistrocerus) difformis* Saussure, 1852. – Et. Fam. Vesp.: 145.

Locality: Saudi Arabia: Abu Arish hot springs, 28.I.83, ♀ 3 ♂♂ (KMG).

Distribution: N. Africa, Niger.

**_Pseudonortonia_** sp.

In BMNH there are two reddish male specimens from South Yemen, Abyan, 21.V.1967 (KMG). They are possibly the unknown males of *Pseudonortonia scotti,* but more material of both sexes is awaited.

Prof. Soika has kindly confirmed that his identification names on the labels of these two specimens are unpublished MS names.

### ***Pseudonortonia scotti*** Giordani Soika, 1957

*Pseudonortonia scotti* Giordani Soika, 1957. – Hymenoptera. Vespidae. Expedition to South-West Arabia, 1937–8, (1) *31:* 479.

An Arabian endemic known from two females, North Yemen and South Yemen, both at 4500 ft. Male unkown for certain (see above).

### ***Pseudonortonia bicarinatus*** n. sp.

Holotype: ♀, Saudi Arabia: Wadi Majarish below Taif 800 m, 12.II.1983, K.M. Guichard, BMNH.

Holotype ♀. A black and white species with two well defined transverse carinae on T1.

Clypeus longer than wide, smooth and shining, laterally with silver decumbent pubescence, apical emargination shallow, about as wide as the distance between the eye sockets. Head strongly and closely punctuate. Front margin of pronotum slightly curved and right-angled laterally. Thorax elongate, more than twice as long as wide at the pronotum, strongly and closely punctuate; mesopleurae rather dull with large punctures. Dorsal area of propodeum reticulate-rugose, sides dull with some large shallow punctures posteriorly. T1 with well defined basal carina and immediately behind it a narrow indefinitely ridged zone followed by a dull impunctuate area bordered by a second carina. Remainder of T1 strongly and closely punctuate. T2 with rather sparser and smaller punctuation, the ground between the punctures microscopically coriaceus and hardly shining.

Insect black with the following parts white: underside of scape, part clypeus, front border of pronotum, part tegulae, post-tegulae, two spots on postscutellum, most of tibiae, most of tarsi except tips, a lateral mark on mid-coxae, apical spot on front femora, apical margin of T1, T2 and S2. Tips of antennae paler beneath. Wings clear except marginal cell slightly infuscate.

### ***Pseudonortonia tilkiani*** n. sp.

Holotype: ♂, Saudi Arabia: Wadi Majarish below Taif 800 m, 12.II.83, K.M. Guichard, BMNH. – Paratypes: 2 ♀♀, Saudi Arabia: Taif Escarpment Road 1000 m, 9.IV.1980, K.M. Guichard, in col. mea.

Holotype ♂. A black and white species related to *Pseudonortonia aegyptiaca* (Saussure, 1863).

Clypeus nearly as long as wide, punctuate, more closely at the sides, moderately shining, apical emargination deep and narrow, clearly narrower than distance between eye sockets. Antennae not conspicuously thickened at segments 9–11, the antennal hook long, narrow and gently curved. Head strongly punctuate. Front margin of pronotum straight, lateral angles rounded. Length of thorax rather more than twice the width at pronotum, closely and coarsely punctuate, the interstices narrower than diameter of punctures. Mesopleurae moderately shining, the punctuation denser below. Propodeum reticulate-rugose with decumbent white pubescence. T1 narrow, not much wider than width of scutellum, strongly and closely punctuate but less so behind the basal carina. T2 much wider than T1 and basally abruptly expanding from it, punctuation similar to that of T1. T3 coarsely and very closely punctuate right across the tergite. S2 rather shining, the large punctures unevenly distributed.

Insect black with the following parts white: jaws except extreme base and brownish tips, clypeus, underside of scape, small dot behind eye, front margin of pronotum, tegulae, post-tegulae, two spots on postscutellum, most of tibiae and tarsi, front and mid-femora with exterior apical spot, apical margin of T1, T2 and S2 with undulate border, transverse patches on T3–6. Length 6 mm.

Female differs from the male as follows: Clypeus covered with silver decumbent pubescence which leaves punctuation clearly visible. Jaws brown, paler basally. Clypeus white, invaded from the base by a large dark spot not reaching the apex. White border of pronotum not reaching the sides. Front and mid-tibiae largely white. Wings clear with distal half of marginal cell infuscate (wings of ♂ holotype are deficient).

***Antepipona yemenensis*** (Giordani Soika, 1957)

*Odontodynerus yemenensis* Giordani Soika, 1957. – Hymenoptera: Vespidae. Expedition to South-West Arabia 1937–8, (1) *31:* 480.

Localities: Saudi Arabia: Taif 2000 m, IV.80, 7 ♀♀ (KMG); An Nimas, IV.80, ♂ (KMG).

Distribution: Arabian endemic. Yemen 2500 m.

The undescribed male is very like the female. The orange markings on head, thorax and T1 and T2 are identical except that on the head the orange of the clypeus, the jaws, the expanding mark between the antennal sockets, the line bordering the inner lower lobe of the eye and the lower side of the scape is replaced by yellow. The transverse clypeus is shaped like that of the female but with the apical points not emerging as free identities, and there is no network of short vertical ridges between the punctures. The orange antennal hook is fairly long, gently curved and rounded at the tip. This species has only occurred at high altitudes – c. 2000 m.

***Antepipona cingulifer*** (Walker, 1871)

*Odynerus cingulifer* Walker, 1871. – List Hym. Egypt: 37.

Localities: Saudi Arabia: Hada Asham near Jeddah, V.80, 2 ♀♀ (KMG); Wadi Majarish below Taif, 12.II.80, ♀ (KMG).

Distribution: Egypt, Arabia including Yemen.

***Antepipona kassalensis*** (Giordani Soika, 1939)

*Odynerus kassalensis* Giordani Soika, 1939. – Ann. Mus. civ. Stor. nat. Genova *60:* 359 (♀).

Locality: Saudi Arabia: Abu Arish, III.80, 5 ♀♀ 4 ♂♂ (KMG).

Distribution: Oman, Sudan, Mali.

This species includes colour forms. In Sudan specimens the tegulae are white in both sexes. In Arabian specimens the tegulae are red in 6 ♀♀ and 5 ♂♂, while the tegulae are black in one of each sex with one male being intermediate.

***Antepipona omanensis*** Giordani Soika, 1979

*Antepipona omanensis* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 282.

Locality: Saudi Arabia: Hofuf, IV.80, 2 ♀♀ ♂ (KMG).

Distribution: Arabian endemic including Oman.

***Antepipona arabica*** Giordani Soika, 1979

*Antepipona arabica* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 281.

An Arabian endemic only known from Oman.

***Antepipona*** sp.

Locality: Saudi Arabia: Wadi Majarish below Taif, II.80, ♀ (KMG).

A black and white species with white tegulae, a white-marked clypeus and white legs. Taken at wet sand at a drinking point for camels.

***Pseudodontodynerus brittoni*** (Giordani Soika, 1957)

*Odontodynerus brittoni* Giordani Soika, 1957. – Hymenoptera: Vespidae. Expedition to South-West Arabia 1937–8, (1) *31:* 477.

Locality: Abu Arish, II.83, 2 ♀♀ (KMG).

An Arabian endemic described from the Yemen. Type in BMNH.

***Allodynerus dignotus*** (Morawitz, 1895)

*Odynerus (Lionotus) dignotus* Morawitz, 1895. – Hor. Soc. ent. ross. *29:* 457.

Localities: UAE: Hatta, 7.XII.81, ♀ (G. Roche). Oman: Wadi Jizi, 19.XI.82, ♀ (I.L. Hamer).

Distribution: S.W. Asia, Arabia including other localities in Oman.

***Allodynerus vinciguerrae*** (Guiglia, 1929)

*Odynerus (Lionotus) vinciguerrae* Guiglia, 1929. – Ann. Mus. civ. Stor. nat. Genova *53:* 402.

Localities: UAE: Wahlah, 28.XI.82, ♀ (I.L. Hamer); Khor Fikkan, 30.III.84, ♀ (I.L. Hamer). Oman: Abool, 31.XII.82, 2 ♀♀ ♂ (I.L. Hamer).

Just seen and not in key. Easily distinguished from *A. dignotus* by the cream instead of yellow markings and all the femora being at least partly ferruginous. In *vinciguerrae* the tips of the tegulae are much more curved and slender.

Distribution: North Africa, Palestine.

***Pseudepipona multicolor dhufariensis*** Giordani Soika, 1957

*Pseudepipona (Parepipona) multicolor* (Saussure) ssp. *dhufariensis* Giordani Soika, 1957. – Hymenoptera: Vespidae. Expedition to South-West Arabia 1937–8, (1) *31:* 477.

Locality: Saudi Arabia: Fayfa, V.83, ♂ (KMG).

Described from a Dhofar female, this subspecies differs only slightly from the African one. The male from Fayfa has yellowish apical bands on T1–5 and the propodeum is smoother and more shining than both African specimens and the Dhofar female in BMNH.

***Pseudepipona magretti*** (Gribodo, 1884)

*Odynerus magretti* Gribodo, 1884. – Ann. Mus. civ. Genova, *21:* 290.

Locality: Saudi Arabia: Fayfa, 29.I.83, ♀ ♂ (KMG).

Distribution: East Africa and Yemen. There is a ♂ in BMNH from Lahej near Aden misidentified as *Rhynchium synagroides* Saussure.

***Pseudepipona nekt*** (Giordani Soika, 1943)

*Odynerus (Rhynchium) nekt* Giordani Soika, 1943. – Boll. Mus. civ. Stor. nat. Venezia *3:* 36.

Locality: UAE: Umm Al Nar, 6.XI.81, ♂ (J.N.B. Brown) col. G. Roche.

Distribution: Egypt, UAE.

***Tricariodynerus arabicus*** n. sp.

Holotype: ♀, Saudi Arabia: Hada Asham near Jeddah, 13.IV.1980, K. Guichard, BMNH. – Paratype: ♂, Wadi Nimar 1500 m, 19.V.1983, W. Büttiker.

Closely related to the tropical African *T. guerini* (Saussure, 1852) but distinguished from that species by the fine punctuation on T1 and T2, the yellow T2 and the more widely transverse clypeus of the female (fig. 45) which has a shallow apical emargination, not deep and semicircular as in *guerini. T. arabicus* shares the folllowing easily observed characters with *T. guerini:* robust form, outstanding carina

along front edge of pronotum which is emarginate in the middle, the vertical and smooth face of postscutellum and the strongly depressed and punctuate S2.

This small well defined group of eumenids with two carinae on the mesonotum was treated by Giordani Soika (1937).

***Antodynerus ignaruris*** (Kohl, 1907)

*Odynerus (Leionotus) ignaruris* Kohl, 1907. – Denkschr. Akad. Wiss. Wien *71:* 88.

An Arabian endemic. The type was described from Ras Fartak, South Arabia, and another female was collected in Dhofar, Ayun Pools, 10.X.77 (KMG).

***Synagris spiniventris*** (Illiger, 1802)

*Vespa spiniventris* Illiger, 1802. – Mag. Insektenk. *1:* 190.

Localities: Saudi Arabia: Fayfa 200 m, 29.I.83, ♂ (KMG); Wadi Maraba, 30.III.80, ♀ (KMG).

Distribution: Tropical Africa, Arabia including South Yemen.

***Euodynerus excellens*** (Perez, 1907)

*Odynerus (Lionotus) excellens* Perez, 1907. – Bull. scient. Fr.-Belg. *41:* 493.

Localities: Saudi Arabia: Hofuf, 24.IV.80, 2 ♀♀ 6 ♂♂ (KMG); Hofuf, 19.V.81, ♀♂ (Talhouk); Riyadh, 18.IV.80, ♀ ♂ (KMG). Qatar, May and June and August to November 1979–80, 4 ♀♀ 18 ♂♂ (G. Roche).

Distribution: S.W. Asia, Iran, W. India.

***Euodynerus sinaiticus*** (Giordani Soika, 1939)

*Odynerus (Rhynchium) tectus* var. *sinaiticus* Giordani Soika, 1939. – Bull. Soc. Fouad I Ent. *23:* 6.

Localities: Saudi Arabia: Taif 2000 m, 8.IV.80, 5 ♀♀ ♂ (KMG); Taif, 8.X.78, ♂ (Talhouk); Wadi Maraba, 30.III.80, ♂ (KMG); Abha, 6.VI.72, ♀ (G. Popov); Abu Arish, 28.I.83, ♂ (KMG); Wadi Majarish below Taif, 12.II.83, ♂ (KMG).

Distribution: Sinai, Arabia including Yemen.

***Euodynerus niloticus ebneri*** (Schulthess, 1921)

*Odynerus (Lionotus) ebneri* Schulthess, 1921. – Anz. ost. Akad. Wiss. *57(1920):* 286.

Localities: Saudi Arabia: Riyadh, 17.IV.80, 4 ♀♀ (KMG); Hakinah, 15.V.80, ♀ (W. Büttiker). UAE: Ras Al Gharab, 29.X.81, ♂ (J.N.B. Brown). Abu Dhabi, 22.X.81, ♀ (G. Roche), 1.VI.81, 2 ♀♀ (G. Roche).

Distribution: Egypt, Sudan, Palestine, Arabia.

***Euodynerus stigma*** (Saussure, 1863)

*Odynerus stigma* Saussure, 1863. – Mem. Soc. Phys. Hist. nat. Genève *17:* 219.

Localities: Saudi Arabia: Riyadh, 18.V.80, ♀ (Talhouk); Wadi Juraisi, 30.V.80, ♀ (W. Büttiker); below Taif 100 m, 9.IV.80, ♀ (KMG).

Distribution: Egypt, Ethiopia, Sahara, Dhofar (colour form ssp. *arabica* Giordani Soika).

***Euodynerus familiaris*** (Giordani Soika, 1939)

*Odynerus (Rhynchium) familiaris* Giordani Soika, 1939. – Bull. Soc. Fouad I Ent. *23:* 3.

Locality: Saudi Arabia: Wadi Majarish below Taif, V.83, ♂ (KMG).

Distribution: Egypt, Palestine, Arabia including Oman.

A pale colour form from Muscat has been named ssp. *muscatensis* Giordani Soika.

***Euodynerus sulfuripes*** (Morawitz, 1885)

*Lionotus sulfuripes* Morawitz, 1885. – Hor. Soc. ent. ross. *19:* 169.

Localities: Saudi Arabia: Hofuf, IV.80, 8 ♀♀ 4 ♂♂ (KMG), at flowers of *Flaveria trinerva;* Al Ghat, 9.IV.82, ♂ (D.H. Walker).

Distribution: Iran, Irak, East Arabia.

***Euodynerus rhynchoides*** (Saussure, 1853)

*Odynerus (Leionotus) rhynchoides* Saussure, 1853. – Et. Fam. Vesp. *1:* 152.

Locality: Saudi Arabia: Abu Arish, 28.I.83, ♀ ♂ (KMG).

Distribution: Egypt, Sudan, North Africa, W. Arabia.

***Euodynerus salzi*** (Giordani Soika, 1952)

*Pseudepipona (Euodynerus) salzi* Giordani Soika, 1952. – Boll. Mus. civ. Stor. nat. Venezia *6:* 42.

Localities: Saudi Arabia: Riyadh, 18.IV.80, ♂ (KMG); El Ha'ir near Riyadh, 30.IV.80, ♀ (KMG); Wadi Juraisi, 30.V.80, ♀ (W. Büttiker); Wadi Rasid, 18.VI.82, ♀ ♂ (D.H. Walker).

Distribution: Palestine, Tibesti, Arabia.

***Euodynerus soikai*** n. sp.

Holotype: ♂, Saudi Arabia: Wadi Maraba below Abha 300 m, 30.III.1980, K.M. Guichard, BMNH.

A mostly ferruginous species with impunctuate T1 and thus related to the African *E. meyeri* (Cameron, 1910).

Clypeus rounded, evenly and rather sparsely punctuate, the apical emargination shallow and about as wide as the space between the antennal sockets. Antennal hook (fig. 46). Head closely and strongly punctuate. Pronotum with only a slightly raised front margin, the lateral angles rounded. Pronotum and mesonotum strongly and evenly punctuate. Scutellum with larger and closer punctuation. Postscutellum serrate with a central emargination. Propodeum with upper carina weak, lower emargination deep leaving two outstanding central teeth. Abdomen with T1 dull and impunctuate, T2 similar except for an apical band of strong punctures which are repeated on T3 and T4, the remaining tergites being dull and impunctuate. S2 centrally shining, strongly punctuate except basally, S3–5 sparsely punctuate. Pubescence everywhere very short and inconspicuous.

Whole insect ferruginous with the following parts white – clypeus, a roughly triangular mark between and above the antennal insertions and a narrow border along the lower margin of the eyes. Abdomen darkened beyond T2. Wings basally flavous, the remainder blackish with violet reflections. Length 12 mm. ♂ unknown.

Distinguished at once from the other Arabian *Euodynerus* by the dull impunctuate T1 and the upper carinae of the propodeum being only slightly developed. It is not in the key and perhaps does not belong to the genus *Euodynerus* at all.

***Euodynerus*** sp.

A ♂ from the Wadi Hanifa, Riyadh, 21.III.80 (KMG) and a worn tricoloured ♀ from Wadi Rasid (?), 14.V.82 (D.H. Walker) have conspicuous bristles on T2 onwards. The ♂ has the antennal hook short, almost straight and pointed, while the ♀ has a narrowly produced clypeus. They appear to be the two sexes of an undescribed species.

***Syneuodynerus fouadi dhofariensis*** Giordani Soika, 1979

*Syneuodynerus fouadi dhofariensis* Giordani Soika, 1979. – Boll. Mus. civ. Stor. nat. Venezia *30:* 284.

Locality: Dhofar, ♀.

The typical form was described from Egypt (G. Soika 1939) and another colour form from Morocco (G. Soika 1953).

***Xanthodynerus octavus*** (Giordani Soika, 1943)

*Odynerus (Rhynchium) octavus* Giordani Soika, 1943. – Boll. Mus. civ. Stor. nat. Venezia *3:* 37.

Localities: Saudi Arabia: Riyadh, IV.–V.81, 3 ♀♀ 3 ♂♂ (S. Tilkian). Oman: Masirah Island, IV.76, ♂ (KMG).

Distribution: North Africa, Arabia.

The Masirah specimen lacks the transparent spot at the apex of the clypeus present in Egyptian and Saudi specimens.

***Chlorodynerus chloroticus*** (Spinola, 1838)

*Odynerus chloroticus* Spinola, 1838. – Annls Soc. ent. Fr. *7:* 500.

Localities: Saudi Arabia: Riyadh, V, IX, 2 ♀♀ 2 ♂♂ (Talhouk); El Kharj, 28.VI.81, ♀ ♂ (Talhouk); Jeddah, 15.IV.80, 3 ♀♀ 4 ♂♂ (KMG). UAE: Al Saad, 20.III.81, ♂ (G. Roche); Al Babha, 6.III.81, ♂ (G. Roche).

Distribution: North Africa, Sudan, Palestine, Arabia.

***Chlorodynerus kelidopterus*** (Kohl, 1907)

*Rhynchium kelidopterum* Kohl, 1907. – Denkschr. Akad. Wiss. math.-naturw. Kl. *71:* 252.

Localities: Saudi Arabia: Wadi Majarish below Taif, 12.II.83, ♂ (KMG). Qatar, XI, X, 8 ♀♀ 8 ♂♂ (G. Roche). UAE: Hatta, 24.VIII.84, ♂ (I.L. Hamer). Riyadh, V, IX, 3 ♀♀ 2 ♂♂ (Talhouk).

Distribution: North Africa, Palestine, Oman, Aden.

***Rhynchium oculatum*** (Fabricius, 1781)

*Vespa oculata* Fabricius, 1781. – Spec. Insect. *1:* 463.

Localities: Saudi Arabia: Fayfa, 29.I.83, ♀ ♂ (KMG). North Yemen: Medina El Abid, V.80, ♂ (T. Larsen).

Distribution: Egypt, Iran, S. Europe, Oman, South Yemen.

Colour forms are ssp. *distinguendum* Buysson, 1913 and ssp. *adenense* Giordani Soika, 1957.

***Rhynchium cyanopterum*** Saussure, 1852

*Rygchium cyanopterum* Saussure, 1852. – Et. Fam. Vesp. *1:* 108.

Localities: Saudi Arabia: Jeddah, 15.IV.80, 4 ♂♂ (KMG); Fayfa, 29.I.83, ♀ ♂ (KMG). UAE: Hatta, 7.VIII.82, 2 ♀♀ (I.L. Hamer).

Distribution: N. Africa, Sudan, Palestine, South Yemen.

***Ancistrocerus adenensis*** Giordani Soika, 1952

*Ancistrocerus adenensis* Giordani Soika, 1952. – Boll. Mus. civ. Stor. nat. Venezia *6:* 31.

An Arabian endemic. South Yemen, Jebel Jihaf 7100 ft., X.1937, 1 ♂. “Very close to *A. parietum* (L.), but readily recognized by its mostly ferruginous-red coloration”.

***Ancistrocerus biphaleratus palaestinicus*** Giordani Soika, 1952

*Ancistrocerus palaestinicus* Giordani Soika, 1952. – Boll. Mus. civ. Stor. nat. Venezia *6:* 22.

Locality: Saudi Arabia: Taif 2000 m, 8.IV.80, 9 ♀♀ ♂ (KMG).

Distribution: Palestine. Mt. Sinai 1600 m, IV.75, 5 ♀♀ 2 ♂♂ (KMG). Egypt: Ismailia, 5.IV.83, ♀ (KMG).

The Arabian females have almost completely red legs and yellow bands on T1–4. In the Sinai females the femora are largely black and the yellow bands confined to T1 and T2. The Arabian male has bands on T1–6. SOIKA (1952) considered this a distinct species but without having seen the female.

***Pareumenes enslini*** (Schulthess, 1931)

*Nortonia enslini* Schulthess, 1931. – Mitt. Schweiz. ent. Ges. *15:* 49.

Distribution: Palestine and Arabia.

*Pareumenes mimus* Giordani Soika, 1980, from Dhofar is a striking female colour form of *P. enslini.* The uniform red males of *mimus* are indistinguishable from males of *enslini.* In Dhofar (Wadi Sayq), four males were caught hovering at the entrance to a cave.

***Pareumenes sansibaricus arabicus*** Giordani Soika, 1980

*Pareumenes sansibaricus* ssp. *arabicus* Giordani Soika, 1980. – Boll. Mus. civ. Stor. nat. Venezia *31:* 116.

Locality: Dhofar, Ayun Pools, 10.X.77, 2 ♀♀ (KMG).

This is a reddish colour form of a widespread African species which has the yellow colour more developed.

***Eumenes mediterraneus*** Kriechbaumer, 1879

*Eumenis mediterranea* Kriechbaumer, 1879. – Ent. Nachr. *5:* 85.

Localities: Saudi Arabia, Abha, 15.VII.81, ♀ (A.S. Talhouk). Yemen: Sana'a, 10.V.80, ♀ ♂ (T.B. Larsen).

Distribution: Mediterranean area, W. and C. Asia.

These isolated high altitude records of a common Mediterranean species indicate a relict fauna, similar to the magpie *(Pica pica)* also from the Abha area.

***Afreumenes nigrorufus*** Giordani Soika, 1968

*Afreumenes nigrorufus* Giordani Soika, 1968. – Boll. Mus. civ. Stor. nat. Venezia *18:* 82.

Localities: Saudi Arabia: Fayfa 200 m, 29.I.83, ♀ (KMG); Fayfa, 30.VII.82, ♂ (A.S. Talhouk).

Distribution: Tropical Africa, Arabia.

Apart from one Aden specimen in the Soika collection, these are the first records from Arabia. The Fayfa (Fifa) specimens have very dark wings.

***Delta emarginatum*** (Linnaeus, 1758)

*Vespa emarginata* Linne, 1758. – Syst. Nat. 10th Ed. *1:* 574.

Common and widespread in many Arabian localities including Riyadh and Jeddah. A common African species which constructs mud nests stored with lepidopterous larvae.

***Delta hottentottum elegans*** (Saussure, 1852)

*Eumenes elegans* Saussure, 1852. – Et. Fam. Vesp. *1:* 58.

Localities: Saudi Arabia: Jeddah, 10.II.83, 5 ♂♂ (KMG); Taif 1000 m, 9.IV.80, ♀ (KMG); Wadi Shaibluba, 28.V.82, ♀ (D.H. Walker); Fayfa, 29.I.83, 4 ♂♂ (KMG). UAE, VII, XII, 2 ♀♀ (I.L. Hamer).

Distribution: Egypt, Palestine, Iran, Arabia including Yemen.

**Delta dimidiatipenne** (Saussure, 1852)

*Eumenes dimidiatipennis* Saussure, 1852. – Et. Fam. Vesp. *1:* 51.

Localities: Saudi Arabia: Abu Arish, 27.III.80, ♂ (KMG). Qatar: Al Shahaniyah, 22.VIII.80, ♀ ♂ (G. Roche). UAE: Dibba, X.81, ♀ ♂ (G. Roche); Hatta, XI.81, ♀ (G. Roche).

Distribution: N. Africa, Palestine, Iran, W. India, Oman, Yemen 2600 m.

**Delta campaniforme gracile** (Saussure, 1852)

*Eumenes gracilis* Saussure, 1852. – Et. Fam. Vesp. *1:* 57.

Apparently widespread and continuous-brooded in one colour form or another throughout Arabia including records from Oman, Qatar and UAE.

Distribution: N. Africa, Iran, India.

**Delta asina mixtum** (Giordani Soika, 1944)

*Eumenes (Delta) mixtus* Giordani Soika, 1944. – Att. Ist. veneto Sci. *103:* 166.

Common but perhaps less widespread in Arabia than *D. campaniforme.* There are a number of records from Oman across southern Arabia to Jeddah. The range extends into Africa and Palestine.

**Delta lepeleterii** (Saussure, 1852)

*Eumenes lepeleterii* Saussure, 1852. – Et. Fam. Vesp.*1:* 45.

Between 1934 and 1941 Soika referred to *lepeleterii* as a variety of *D. campaniformis* no less than five times in five separate publications. In 1951, however, he raised *lepeleterii* to specific rank and recorded it from S.W. Arabia with a statement concerning "the true *lepeleterii* being an African southern form". I possess a number of *lepeleterii* from southern Africa collected by Empey and bearing 1964 Soika identification labels and they cannot be separated from Arabian material of *asina mixtum.* Prof. Soika, with whom I raised the question of the true identity of *lepeleterii,* is now of the opinion that *Delta asina mixtum* is "probably a subspecies of *lepeleterii,* but not a synonym".

*Delta lepeleterii pilosellum* Giordani Soika, 1981, has been described from near San'a in Yemen – immediately recognizable by the length of the pilosity of the head and thorax and by the colour of the second sternite.

**Delta** sp.

Two Saudi Arabian males, one from Abu Arish and the other from Wadi Majarish below Taif have the same unusual colour pattern. The yellow on the abdomen is reduced to a patch on each side of T2–6. The cruciform mark on T2 is obliterated and the base of T2 is smoky red merging into black. The mesonotum is black, the scutellum and tegulae red. The antennal hook and mid-femora agree with those of *asina mixtum.* Unfortunately a recognizable female is lacking. Since the black cross on T2 seems to be diagnostic for *asina mixtum,* the lack of it, should it appear lacking in the opposite sex when it turns up, may indicate an undescribed species.

**Delta fenestrale** (Saussure, 1852)

*Eumenes fenestralis* de Saussure, 1852. – Et. Fam. Vesp. I (1852): 53.

Localities: Saudi Arabia: Riyadh, 14.V.83, ♀ (A.S. Talhouk); Jizan, 1.II.83, ♂ (A.S. Talhouk); Fayfa, 29.I.83, 2 ♀♀ ♂ (KMG).

Distribution: Tropical Africa, Arabia.

***Delta unguiculatum*** (Villers, 1789)

*Vespa unguiculata* Villers, 1789. – C. Linnaei Entom. *3:* 282.

Locality: Saudi Arabia: Tabouk, 25.VI.83, ♀ (A.S. Talhouk).

Distribution: This species occurs in one colour form or another in the Mediterranean area and North Africa right across to Asia. This only known Arabian specimen is entirely red except for a yellow clypeus, a yellow mark between the eye sockets, a yellow line bordering the eye up to the emargination and broad yellow bands on T2–5. It remains to be seen whether the northern Hejaz is the southern limit of the species in Arabia.

***Ischnogasteroides tenuissimus*** (Giordani Soika, 1941)

*Eumenes (Ischnogasteroides) tenuissimus* Giordani Soika, 1941. – Mem. Soc. ent. Ital. *20:* 97.

Localities: Saudi Arabia: Asir, Wadi Tarya 1400 m, 5.IV.80, ♀ (KMG); Wadi Majarish below Taif, 12.II.83, ♂ (KMG).

Distribution: Egypt, Arabia including Oman.

***Ischnogasteroides leptogaster*** (Walker, 1871)

*Eumenes leptogaster* Walker, 1871. – List Hym. Egypt *30.*

Localities: Saudi Arabia: El Ha'ir near Riyadh, 30.IV.80, ♂ (KMG): Kushm Dibi, 10.X.81, ♀ (W. Büttiker); Wadi Rasid, 18.VIII.82, ♀ (D.H. Walker). Hadhramaut, Seiun, 5.II.85, ♂ (G. Popov).

Distribution: North Africa, Palestine, Arabia including Oman.

***Katamenes niger*** (Brullé, 1839)

*Eumenes nigra* Brullé, 1839. – in Barker-Webb & Berthelot, Hist. nat. Iles Canar. 2, livr. *44:* 89.

Localities: Saudi Arabia: Madain Salih, IV.46, ♀ (D.V. Fitzgerald). Bahrain: Jebel Dukhan, XI.35–II.36, 8 ♀♀ (J. Fernandez, in BMNH).

Distribution: Canaries, North Africa, Arabia.

***Katamenes sichelii coranicus*** Giordani Soika, 1970

*Katamenes sichelii* ssp. *coranicus* Giordani Soika, 1970. – Boll. Mus. civ. Stor. nat. Venezia *20/21:* 177.

Localities: Saudi Arabia: Riyadh, II. IV.59, 2 ♀♀ 2 ♂♂ (D. Diehl, coll. Linsenmaier); Riyadh, Wadi Hanifa, 21.III.80, ♂ (KMG).

Distribution: South Europe, North Africa, Asia.

This species has been plagued with eight colour form names.

***Katamenes rauensis*** (Giordani Soika, 1958)

*Eumenes (Katamenes) rauensis* Giordani Soika, 1958. – Boll. Mus. civ. Stor. nat. Venezia *11:* 62.

Locality: Arabia: Shaib U Salia, 10.III.1934, ♂ (H. St. J.B. Philby).

This specimen is in BMNH and bears a Soika label "*Katamenes arabicus*". Related to *K. sichelii* by the length of the mid-tarsus, the author found the shape of the digitus to indicate the most primitive species in the subgenus. ♀ unknown.

***Katamenes jenjouristei*** (Kostylev, 1939)

*Eumenes jenjouristei* Kostylev, 1939. – Arch. Mus. zool. univ. Moscou *5:* 165.

Localities: Saudi Arabia: Riyadh, 17.IV.80, 2 ♂♂ (KMG); Wadi Shaibluba, 28.V.82, ♀ (D.H. Walker); Jeddah, 10.II.83, 5 ♂♂ (KMG); Fayfa, 29.I.83, 4 ♂♂ (KMG).

Distribution: Palestine, Arabia including Oman.

An Arabian colour form has been named ssp. *rubroniger* Giordani Soika.

## DISCUSSION

In the at present known eumenid fauna forty-eight species can be regarded as wide ranging Eremian representatives, eight as Afro-Tropical and twenty as endemis.

Due to our lack of knowledge concerning the fauna of southern Iran including the Mekran, the relationship between Arabia and those parts is still obscure. However, the East African connection is much clearer. All the Afro-Tropical species are found near the Yemen-Saudi border, while one extends into Dhofar and another reaches northern Oman. There are probably more of these “Africans” awaiting discovery on the Tihama and especially in the rich unexplored valleys leading into the foothills of the Asir, while the whole of Yemen is little known. Another area that would repay investigation is the northern Hejaz and all the border with Iraq.

Despite the limited eumenid material available for study, the distributional picture that emerges agrees well with those for other groups of Arabian insects. The predominance of the Eremian element can be well appreciated when one considers not only recent land connections but the uniform ecological conditions and flora that extend from Morocco through to Iran.

The increasing number of hymenoptera collected and made available for study now reveals a much wider desert and semi-desert distribution than was formerly realized. An interesting example of this was the discovery of *Cyrtolabulus spinithorax* not far from Jeddah, a species that was only known previously from a single specimen of the opposite sex from the Hoggar Mountains in the central Sahara two thousand miles away. Many of these small eumenids are elusive and some are seldom caught even by hymenopterists, although new trapping methods should increase the chances of their discovery.

## ACKNOWLEDGEMENTS

I am most grateful to the Ministry of Agriculture of Saudi Arabia for the opportunity given for the 1980 and 1983 visits to Saudi Arabia, and I am very greatly indebted to Prof. A.S. Talhouk for making the necessary travel and accomodation arrangements and for making available the services of his energetic assistant Sarco Tilkian. During 1980, the Rhein-Ruhr Construction Company working in the Asir and Dr. and Mrs Barkham in Riyadh were most kind in providing accomodation and hospitality. During 1983, I was indebted to the University of Beirut in Riyadh for the use of their guest house and to Mr. and Mrs Gasperetti in Jeddah both for hospitality and for the opportunity to visit the fruitful Wadi Majarish below Taif. The staff of the Hymenoptera Section of the British Museum (Natural History) very kindly provided all facilities for study of material and I am most grateful to Mr. David Morgan for providing the admirable illustrations and to Mr. Michael Day for some timely help.

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# Hymenoptera: Fam. Formicidae of Saudi Arabia

**C.A. Collingwood**

Abstract: This paper lists and keys 164 species of Formicidae of which 156 are first records for the actual territory of Saudi Arabia and 146 are new records for the Arabian peninsula as a whole. Ten species are described as new.

Keywords: Hymenoptera, Formicidae, Arabian peninsula, taxonomy.

نمليات المملكة العربية السعودية

سي . ا. كولنكوود

خلاصة : تضم هذه الدراسة قوائم ومفاتيح تصنيفية لـ ١٦٤ نوعا من النمليات والتي يشكل ١٥٦ نوعا منها تسجيلات جديدة للمملكة العربية السعودية ، بينما يشكل ١٤٦ نوعا تسجيلات جديدة لشبه الجزيرة العربية بشكل عام . كذلك ، تم وصف عشرة أنواع جديدة .

## INTRODUCTION

There are very few references to Arabian ants in existing literature. In all about 16 species have been recorded for the whole peninsula and none from Saudi Arabia itself. Recent collections within Saudi Arabia mainly by Prof. W. Büttiker and amplified by material from other Arabian territories – Yemen Arab Republic, Prof. B. Lanza; Oman, Dr. R.P. Whitcombe, Mr. M. Gallagher; Kuwait, Prof. R.W. Harkness; Dubai, Dr. K. Dumpert, C.A.C. – and material seen in various museums include about 60 species.

A collecting trip sponsored by Mr. Abdul Aziz el Mudbil, Deputy Minister for Agriculture, and arranged through Dr. W. Wittmer of Basel was carried out from 22.III.–18.IV.1983. The journeys included only part of the Central Region, the Asir mountains, the far South West and a small part of the Eastern Region. Much territory in the vast hinterland of Saudi Arabia remains unexplored. The present collections are probably representative of genera such as *Camponotus* and *Cataglyphis* which include a number of large and conspicuous species but probably much remains to be discovered of the more cryptic species. For example no dacetine ants have been collected in Arabia but at least a few species should be present in the remnants of old woodland and in shaded parks.

In this paper I have used existing names as far as possible although many of the previous designations were of infraspecific rank. Many of the older authors made little discrimination between subspecies, stirpes, races and varieties and this has made some difficulties with respect to formal nomenclature procedures where such infraspecific names are clearly not synonyms but would now be regarded as good species. The geographical distribution is given in broad general terms and not by individual countries except with some of the more local species. The main reference collections studied include the Santschi collection at the Natural History Museum Basel (NHMB), the general collection at the British Museum (Natural History) (BMNH) and the Forel collection at the Museum d'Histoire Naturelle, Geneva.

The morphological features used in the text are illustrated in figs 1–2. The keys to genera and species refer to the worker caste only. There are a few records from Oman that refer to un-named species. These will be dealt with separately and the Omani fauna detailed more fully in a separate paper.

## MATERIALS AND METHODS

### Measurements and Indices

I have followed in general the methods of Bolton in his revisionary studies, e.g. BOLTON (1980, 1982) but with certain species I have included additional measurements where appropriate. All measurements are expressed in mm.

| | |
|---|---|
| Total Length (TL): | The total outstretched length of the individual. |
| Head Length (HL): | The length from the mid point of the front clypeal border to the mid point of the occipital border. |
| Maximum Head Length: | The length measured in profile from the clypeal front border to the furthest extent of the occipital margin. |
| Head Width (HW): | The maximum width of the head at its widest point but excluding the eyes. For most species this measurement is taken immediately above the eyes. |
| Scape Length (SL): | The straight line length of the antennal scape not including the condylar bulb. |
| Eye Length (EL): | The maximum diameter of the eye. |
| Cephalic Index (CI): | HW × 100 divided by HL. |
| Scape Index (SI): | SL × 100 divided by HW. |

### Collecting sites

Eastern Region (east of 48°E), 13.IV.–16.IV.1983.

Al Qatif – coastal marsh; date palm cultivated and semi-derelict plantations; adjacent sand dune desert with low shrubs. Hofuf – Agricultural Centre grounds; sand mountain and surrounding desert; parkland with planted tamarisk; cultivated date palm farmland.

Desert and soil litter species with some Middle East faunal elements.

Other collections: – Hofuf, Dammam (A.S. Talhouk, W. Büttiker).

Central Region (north of 23°30'N, 42°–48°E), 22.III.–24.III.1983; 17.IV.–19.IV.1983.

Riyadh – Agricultural Centre grounds and City surrounds. Al Kharj – parkland and desert. Al Kharfah – desert. Al Hair – river valley and neighbouring deserts. Sulaiel – desert (fringes of Al Badi complex).

Desert and oasis species.

Other collections: – Riyadh (A.S. Talhouk). Wadi Jureisi, Al Khubra, Wadi Khumra, Afif, Wadi Dawasir, Wadi Hanifa, Quwayiyah, Hieth, Wadi Batayn, Khashm Khafs, Tumeir, Sanam (W. Büttiker).

Western Region (Red Sea coast, west of 40°E, south of 24°N), 5.IV.–6.IV.1983.

Al Kudeis; Karm Rauish, Shawag – sandy desert with *Spalodora* bush islands. Al Modlif, Mahaiel.

Other collections: – Jeddah City surrounds, Medina, Al Alam, Wadi Ghomra, Wadi Bani Hunayn, Ras Hatibah, Sahl Rakhbar, Tarfa, Wadi Daykah, Makka, Al Farrah, Usfan, Horash, Bahara, Shoiba, Bani Malek (W. Büttiker).

South Western Region (South of 21°N), 24.III.–3.IV.1983.

Fayfa – terraced cultivation with sorghum; river valleys with trees including ancient tamarisks. Abu Arish (Jizan) – resthouse grounds and stony desert scrub surrounds. Sug al Ahad – river valley and

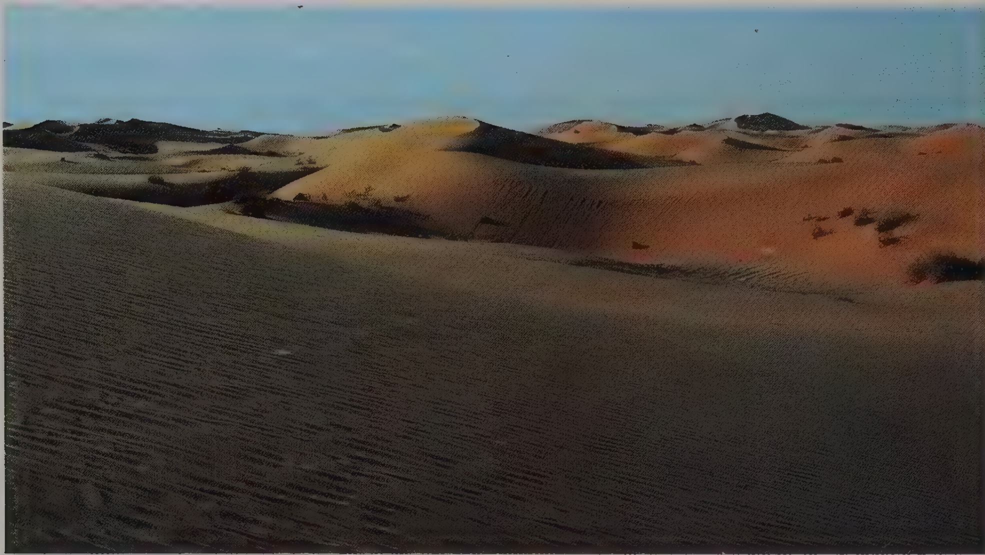


Plate 1: Characteristic habitat for *Cataglyphis* species in the sand dunes of Khureis of the Dahna desert, 120 km NE of Riyadh, November 1981. (Photo W. Büttiker)

Plate 2: Habitat of North African and endemic ant species. Al Mindak district, Baha Province. March 1984. (Photo W. Büttiker)

Plate 3: Habitat of Ethiopian and tropical African ant species. Asir mountains from Jebel Suda near Abha. September 1983. (Photo W. Büttiker)

lakeside. Al Qahman – mangrove swamp and sandy coast. Rich fauna with arboricolous and soil litter species including Afrotropical elements.

Other collections: – Fayfa, Jizan, Anjara, Hakimah (W. Büttiker).

Asir mountains – areas between Al Taif and Abha, mostly land between 1200 and 3000 m asl. Wadi Shugub; Bishah; Anamas; Shaqiq Shamran, Tanuma, Sawdah mountain juniperus forest reserve. Highland fauna with interesting endemics.

Area between Abha and Najran – Al Kola; Zahran (Dharan). Alluvial upland valleys with acacia scrub and old pasture. Savannah species including North African elements.

Other collections: – Wadi Turabah, Wadi Qust; Hesua; Wadi Al Amar; Wadi Turabah/Shuqub, Al Mindak, Jabal Ibrahim, Hama: Wadi Majarish, Wadi Shuwas, Jabal Bushayrah, Bani Musayquirah, Wadi Azizah (W. Büttiker).

Najran – lowland semi-cultivated and derelict pasture with trees including palms.

Other collections: – Wadi Qatan (W. Büttiker) (Büttiker 1981).

Northern Region (north of 24°N, west of 42°E), not visited.

Other collections: – North Hedjaz including Wadi Tabuk/Tobuk, Al Ula, Khaybar, Alam al Asmar, Jal Khartam, Al Farrah, Wadi Tinan (W. Büttiker, King Abdulaziz University – Natural History Museum Basel expedition) (Abo-Khatwa et al. 1980).

A comprehensive list of Saudi Arabian collecting localities is given by Lewis & Büttiker 1982.

## Key to subfamilies (worker caste)

| | | |
|---|---|---|
| 1. | Pedicel with a single node or scale .......... | 2 |
| – | Pedicel with two distinct segments, the petiole and the postpetiole .......... | 5 |
| 2. | Gaster with a projecting sting. First and second gaster tergite with a distinct constriction in between **Ponerinae** | |
| – | Gaster without a projecting sting. First and second gaster tergite not separated by a distinct constriction .......... | 3 |
| 3.(2) | No eyes. Antennal insertions very close to anterior margin of head **Dorylinae** | |
| – | Eyes always present. Antennal insertions separated by a more or less broad frontal shield (clypeus) from anterior margin of head .......... | 4 |
| 4.(3) | Apex of gaster with a circular orifice, in some genera a protruding tube fringed with setae. Petiole a scale or node **Formicinae** | |
| – | Apex of gaster ending in a transverse slit. Petiole a small node partially concealed and overhung by the first gaster segment **Dolichoderinae** | |
| 5.(1) | Clypeus projects backward between the frontal ridges. Eyes small to medium, at most occupying about ¼ total head length. Ocelli absent **Myrmicinae** | |
| – | Clypeus does not project back between the frontal ridges but bends vertically downward in front of the head. Eyes large; ocelli present **Pseudomyrmecinae** | |

### Subfam. **Dorylinae**

### Genus ***Dorylus*** Fabricius

***Dorylus fulvus*** (Westwood, 1840) (figs 2, 3, 4)

*Typhlopone fulvus* Westwood, 1840; Introd. Classif. Insects *2:* 49.
*Dorylus fulvus* (Westwood) Emery, 1895; Zool. Jb. Abt. Syst. *8:* 707.

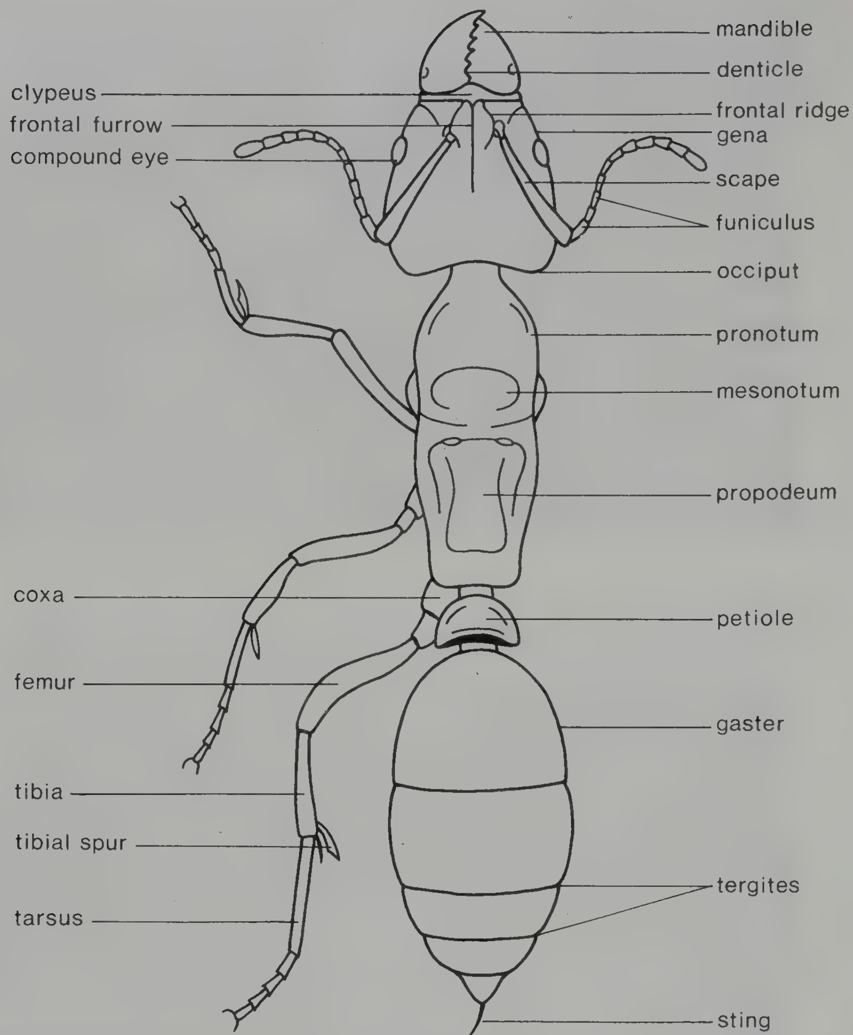
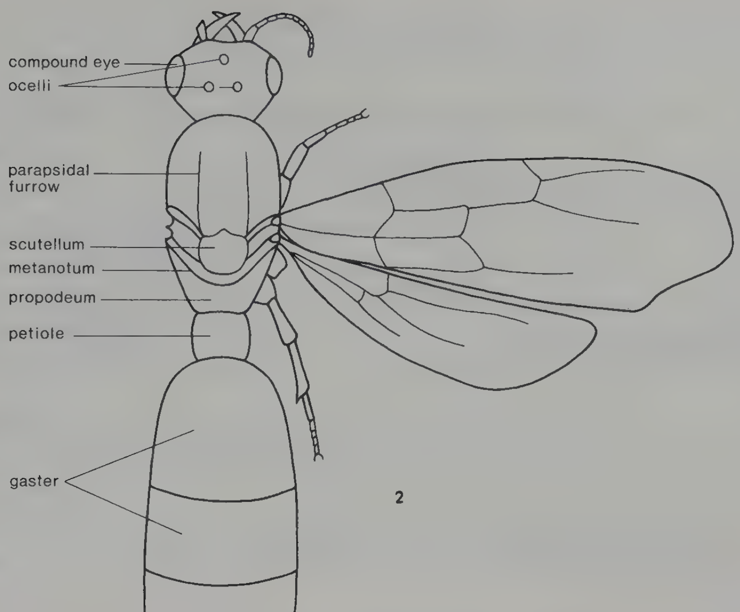



Fig. 1: *Pachycondyla senaarensis* ☿, dorsal view to show morphological features.

Hofuf, King Faisal University collection; ♂♂ Shaker M. Hammad. Riyadh, Department of Agriculture collection; ♂♂. Fayfa 29.III.83; Abu Arish 3.IV.83; ♂♂. Fayfa tamarisk grove 29.III.83; Najran 10.IV.83; ♀♀ CAC. Jebel Ibrahim 10.VII.83; ♂ W. Büttiker.

The first Arabian record for this ant is from Makalla, leg. O. Simony (Wheeler 1922). It is the only species of this subfamily so far represented in Arabia. It has a very wide distribution through the Northern half of Africa and occurs also in the Middle East. The large wasp-like males, up to 25 mm long, fly in numbers to light mainly in the early months of the year. The pale yellowish brown workers are small and blind and are seldom seen above ground. A small group was found under a stone in a wooded valley at Fayfa while at Najran, a mutilated worker was seen still attached to the mid tibia of a worker of *Camponotus aegyptiacus,* a noctural species.

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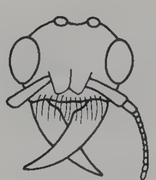

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Figs 2, 3: *Dorylus fulvus* ♂. 2, dorsal view to show morphological features; 3, head in frontal view. (Scale bar 1 mm).

## Subfam. **Ponerinae**

| List of species: | Geographical distribution: |
|---|---|
| *Anochetus sedilloti* Emery, 1884 | North Africa, India |
| *Anochetus traegaordhi* Mayr, 1903 | Northeast and tropical Africa |
| *Belonopelta loebli* Baroni Urbani, 1975 | Middle East |
| *Cerapachys longitarsus* (Mayr, 1878) | Northeast Africa, West India |
| *Cerapachys wittmeri* n.sp. | Saudi Arabia |
| *Cryptopone ochracea* (Mayr, 1885) | South Europe |
| *Hypoponera abeillei* (André, 1881) | South Europe, North Africa |
| *Hypoponera eduardi* (Forel, 1894) | South Europe, Middle East, North Africa |
| *Hypoponera punctatissima* (Roger, 1859) | Cosmopolitan |
| *Hypoponera ragusai* (Emery, 1895) | Sicily, Middle East, North Africa |
| *Leptogenys maxillosa* (Smith, 1858) | Tropicopolitan tramp |
| *Pachycondyla ambigua* André, 1890 | Tropical Africa |
| *Pachycondyla senaarensis* (Mayr, 1862) | Africa |
| *Platythyrea modesta* Emery, 1899 | Tropical Africa |

Most of the above species are small, hypogaeic and seldom seen above ground. Only the ubiquitous *Pachycondyla senaarensis* is a daylight and crepuscular surface forager commonly seen in some numbers.

## Key to species

1. Mandibles inserted in middle of anterior margin of head, occiput widely emarginate ***Anochetus*** Mayr 2
– Mandibles inserted at sides of anterior margin of head; occiput not emarginate ...... 3
2.(1) Eye about 0.16 × maximum head length; mesonotum not striate; petiole tapering to dorsal crest ***Anochetus traegaordhi*** Mayr
– Eye about 0.22 × maximum head length; mesonotum laterally striate; petiole with evenly convex dorsal crest in side view ***Anochetus sedilloti*** Emery
3.(1) Mandibles falcate; median portion of clypeus projects as a lobe; tarsal claws pectinate ***Leptogenys*** Roger
– Mandibles denticulate; clypeus either not projecting or as a sharp cone; tarsal claws simple. ........ 4
4.(3) Pygidium armed dorsally with a row of denticles on each side; antennal insertions close to centre line but condylar bulbs not concealed by frontal lobes; alitrunk dorsally without visible sutures ***Cerapachys*** Smith 5
– Pygidium not denticulate; antennal insertions concealed by frontal lobes; dorsum of alitrunk with at least one visible suture ........ 6
5.(4) Apical funiculus segment swollen to form a large single segmented club; eyes very small but distinct ***Cerapachys wittmeri*** n.sp.
– Apical three segments together forming a club; eyes very large ***Cerapachys longitarsus*** (Mayr)
6.(4) Propodeum and petiole node each bituberculate posterodorsally; petiole with two lateral teeth and a low median lobe posterodorsally ***Platythyrea modesta*** Emery
– Propodeum and petiole both unarmed posterodorsally ........ 7
7.(6) Basal portion of mandible with a distinct dorsolateral pit ........ 8
– Basal portion of mandible without a dorsolateral pit ........ 9
8.(7) Middle tibia with a single pectinate spur; metanotal suture weak; small yellowish species; eyes minute ***Cryptopone ochracea*** (Mayr)
– Middle tibia with two spurs, one small simple and one large pectinate; metanotal suture a deep furrow; robust dark coloured species; eyes moderately large ***Pachycondyla senaarensis*** (Mayr)
9.(7) Middle tibia with two spurs, one small simple and one large pectinate; eyes small but clearly visible ***Pachycondyla ambigua*** André
– Middle tibia with a single spur; eyes very small or absent ........ 10
10.(9) Middle tibial spur short and simple. Mandibles elongate with five large teeth. Clypeus produced anteriorly into a sharp cone ***Belonopelta loebli*** Baroni Urbani
– Middle tibial spur distinctly pectinate. Mandibles triangular not elongate, with 6 or more small denticles ***Hypoponera*** Santschi 11
11.(10) Frontal furrow continued as a thin line almost to occiput ***Hypoponera punctatissima*** (Roger)
– Frontal furrow continued to three quarters of the way towards occiput or less ...... 12
12.(11) Antennal scape reaching occiput; body colour dark ***Hypoponera eduardi*** (Forel)
– Antennal scape not extending as far as occiput; body colour light testaceous brown .. 13
13.(12) Dorsal surface of alitrunk plane with only metanotal suture faintly indicated ***Hypoponera abeillei*** (André)

– Dorsal surface of alitrunk interrupted by shallow but distinct metanotal suture
***Hypoponera ragusai*** (Emery)

## Genus ***Anochetus*** Mayr

***Anochetus sedilloti*** Emery, 1884

*Anochetus sedilloti* Emery, 1884; Annali Mus. civ. Stor. nat. Giacomo Doria *21:* 377.

Fayfa 28.III.83; 1 ☿CAC.

A single worker was taken foraging on the soil surface at a roadside bank in early morning.

***Anochetus traegaordhi*** Mayr, 1903 (fig. 5)

*Anochetus traegaordhi* Mayr, 1903; in Jaegerskjoeld, 1903 Exp. *9* Formicid.: 2.

Fayfa 30.III.83; ☿☿ CAC.

Two workers were collected on the surface foraging under bushy scrub.

## Genus ***Belonopelta*** Mayr

***Belonopelta loebli*** Baroni Urbani, 1975 (figs 6, 7)

*Belonopelta loebli* Baroni Urbani, 1975; Mitt. schweiz. ent. Ges. *48:* 307.

Al Qatif 14.IV.83; 1 ☿ CAC.

A single worker of this uncommon species was found in soil litter under a date palm. The type was collected from the neighbourhood of Lake Tiberias, Galilee by Dr. I. Loebl. The Arabian record is only the second known locality for this species. The specimen from Al Qatif is slightly larger and darker than the described type but in all other respects accords with the description and keys of Baroni Urbani (1975).

## Genus ***Cerapachys*** Smith

***Cerapachys longitarsus*** (Mayr, 1878)

*Lioponera longitarsus* Mayr, 1878; Verh. zool.-bot. Ges. Wien *28:* 669.

*Cerapachys longitarsus* (Mayr) Brown, 1975: 23.

Abu Arish resthouse at light 2.IV.83; ♀♀ CAC.

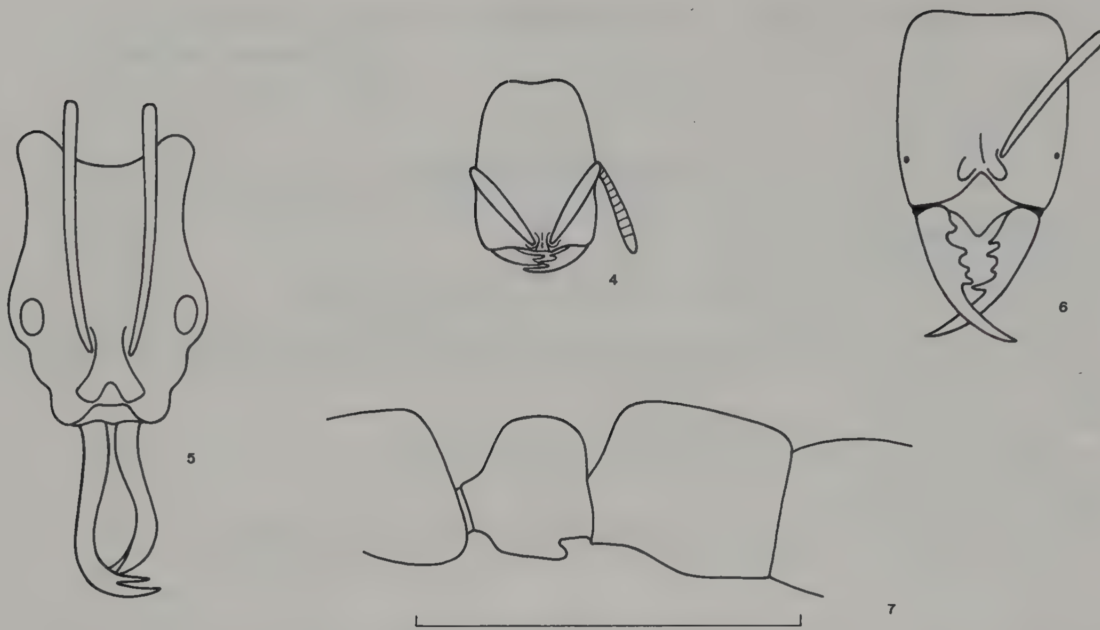
Three dealate queens were taken on the ground beneath a light trap at night. This species is recorded as nesting in hollow twigs and the three queens at Abu Arish may have fallen to the ground after a post nuptial dispersal flight.

Until the revision of the Cerapachyini by Brown (1975), this species was variously assigned to *Lioponera* or *Phyracaces* which genera are now sunk as synonyms of *Cerapachys*. *C. longitarsus* is a very wide ranging species and is recorded from North Australia, the Philippines, several localities in western India and also from North Africa. The very similar and probably synonymous *C. braytoni* (Weber 1949) was described from Kenya, East Africa.

***Cerapachys wittmeri*** n.sp. (fig. 8)

Al Kola semi cultivated area 10.IV.83; 12 ☿☿ CAC.

These were found loosely assembled in soil under a stone in grazed scrubby pasture near a village.




Figs 4–6: Head in dorsal view. 4, *Dorylus fulvus* ☿; 5, *Anochetus traegaordhi* ☿; 6, *Belonopelta loebli* ☿. Fig. 7: *Belonopelta loebli* ☿, petiole and first gaster segment in profile view. (Scale bar 1 mm).

The species clearly belongs to the *C. cribrinodis* Emery group in its general morphology but differs in the relatively small eyes which are nevertheless larger than in the minute eyed *C. piochardi* from the Middle East.

Holotype worker: TL 4.1; HL 0.81; HW 0.70; SL 0.45; EL 0.09; petiole length 0.450, width 0.451; apical funiculus segment 0.40; CI 86.4; SI 64.3.

Colour uniformly reddish brown with articulations and base of mandibles darker. Sculpture diffusely punctulate over whole body, denser on the petiole. Long scattered pubescence over whole body and appendages, longer hairs restricted to clypeus and apex of gaster. General appearance moderately shining.

Head longer than broad with a distinct chitinous flange dorsolaterally with angular produced occipital corners widely emarginate between. Sides of head moderately curved. Clypeus with straight front border extended backward between narrow raised frontal ridges. Antennae 12 segmented, insertions not concealed; scapes short broadening distally to enclose partially the first funiculus segment. Funiculus terminates in very large apical segment as long as 7 preceding segments together. Eyes small, about one eighth head width, 12 facetted.

Alitrunk without dorsal sutures; pronotum with obliquely angled shoulders; propodeum broadly emarginate posteriorly with concave descending face; node large and simple about as broad as long with a broad anteroventral lobe. First gaster segment separated by a deep girdle from the larger and longer second segment. Gaster apex armed with short spines partially obscured by setae.

Holotype and paratypes in NHMB; paratype in BMNH.

This species appears to belong to the *C. cribrinodis* group but has smaller eyes and a comparatively narrower petiole than any of the species mentioned by Brown (1975), in his review of the Cerapachyini except *C. peringueyi* Arnold of South Africa.

### Genus *Cryptopone* Emery

***Cryptopone ochracea*** (Mayr, 1855)

*Ponera ochracea* Mayr, 1855; Verh. zool.-bot. Ges. Wien *5:* 118.
*Cryptopone ochracea* (Mayr) Emery, 1916; Boll. Soc. ent. ital. *47:* 206.

Fayfa 30.III.83; 1 ☿ CAC.

A single worker was taken in leaf litter under bushy trees.

### Genus *Hypoponera* Santschi

***Hypoponera abeillei*** (André, 1881)

*Ponera abeillei* André, 1881; Bull. Soc. ent. Fr. : 48.
*Hypoponera abeillei* (André) Taylor, 1967: 12.

Abu Arish resthouse grounds 2.IV.83; ☿☿ CAC.

These were taken in leaf litter beneath a hedge. This small yellowish brown species is characterised by the flat outline of the alitrunk dorsum which has only a very slight metanotal impression. It has a more shining appearance and a thicker petiole node than *H. punctatissima* and, seen from above, the node narrows anteriorly more abruptly than in *H. ragusai.*

***Hypoponera eduardi*** (Forel, 1894)

*Ponera eduardi* Forel, 1894; Bull. Soc. vaud. Sci. nat. *30:* 15.
*Hypoponera eduardi* (Forel) Baroni Urbani, 1968; Annali Mus. civ. Stor. nat. Giacomo Doria *77:* 416.

Al Qatif 14.IV.83; ☿☿ CAC. Oman: Khabura 31.XII.79; 1 ♀ R.P. Whitcombe.

The Al Qatif workers were taken from under a stone in a shaded palm grove. The Oman example was taken from the stomach of a swift (*Apus pallidus*).

***Hypoponera punctatissima*** (Roger, 1859) (fig. 9)

*Ponera punctatissima* Roger, 1859; Berl. ent. Z. *3:* 266.
*Hypoponera punctatissima* (Roger) Taylor, 1967: 13.

Abu Arish 2.IV.83; Fayfa 31.III.83; ♀♀ CAC.

These queens were caught flying in the neighbourhood of light traps. This cosmopolitan species has a very wide distribution through Europe, Africa and Asia.

***Hypoponera ragusai*** (Emery, 1895)

*Ponera ragusai* Emery, 1895; Naturalista sicil. *14:* 28.
*Hypoponera ragusai* (Emery) Baroni Urbani, 1971: 18.

Riyadh Agricultural Centre 19.IV.83; ☿☿ CAC.

This species has been recorded from Sicily, Egypt and East Africa. Its identification is tentative pending a revision of this difficult genus of small hypogaeic ants.

### Genus *Leptogenys* Roger

***Leptogenys maxillosa*** (Smith, 1858)

*Ponera maxillosa* Smith, 1858; Catalogue of Hymenopterous Insects in the collection of the British Museum, Formicidae: 93.
*Leptogenys maxillosa* (Smith) Roger, 1861; Berl. ent. Z. *5:* 43.

Fayfa 30.III.83; 1 ☿ CAC. Oman: Dhofar 9.XII.84; ☿☿ M. Gallagher.

This was collected in leaf litter by the side of a track under shrubs. The species is a wide ranging tropical tramp. The projecting clypeus has a narrow translucent fringe and the mandibles are long moderately curved and falcate. The African species of this genus have been revised by BOLTON (1975).

## Genus *Pachycondyla* Smith

### *Pachycondyla ambigua* André, 1890

*Pachycondyla ambigua* André, 1890; Annls. Soc. ent. Belg. *45:* 47.

Fayfa cultivated valley with trees 31.III.83; 1 ☿ CAC.

This single example was seen foraging on the soil surface in tree shade. According to Bolton (pers. commun.), this species is widely distributed through Africa although only the type locality Sierra Leone is listed by WHEELER (1922).

### *Pachycondyla senaarensis* (Mayr, 1862) (figs 1, 10)

*Ponera senaarensis* Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 72

*Pachycondyla senaarensis* (Mayr) André, 1890; Revue Ent. *9:* 316.

Dammam 18.IV.78; ♂ ☿☿ ♀ W. Büttiker. North west of Tobuk 24.IV.79; ♀ KAU-NHMB expedition. Riyadh Agricultural Centre 22.III.83; Fayfa resthouse and village environs 27.III.83; 30.III.83; Abu Arish resthouse 25.III.83; Mahaiel 4.IV.83; ☿☿ ♀♀ CAC. Dubai 2.VIII.72; ☿☿ CAC. Socotra IV.67; ♂♂ ☿☿ K.M. Guichard. Oman: Dhofar 1978, 1979; ☿☿ R.P. Whitcombe.

This agressive species is distributed throughout the African tropics and evidently reaches its northern limit in Arabia since it is not known to occur in any of the countries of the Middle East. It is common around village settlements and because of its vicious sting is regarded as a pest in some areas. This species feeds mainly on dead insects but is also attracted to sugary substances and food waste. It flourishes around night time illuminated petrol stations where many night flying insects tend to congregate and fall to the ground.

Hitherto it was the only Ponerine species known in Arabia and was recorded from Muscat, Aden, Tes and other places in South Arabia by EMERY (1881).

## Genus *Platythyrea* Roger

### *Platythyrea modesta* Emery, 1899 (fig. 11)

*Platythyrea modesta* Emery, 1899; Annls. Soc. ent. Belg. *43:* 467.

Fayfa cultivated valley 30.III.83; ♂ ☿☿ CAC.

Specimens were taken during bright sunshine on exposed rock. It is an active predator with a relatively sharp sting. It is recorded from the Sudan, west and central Africa.

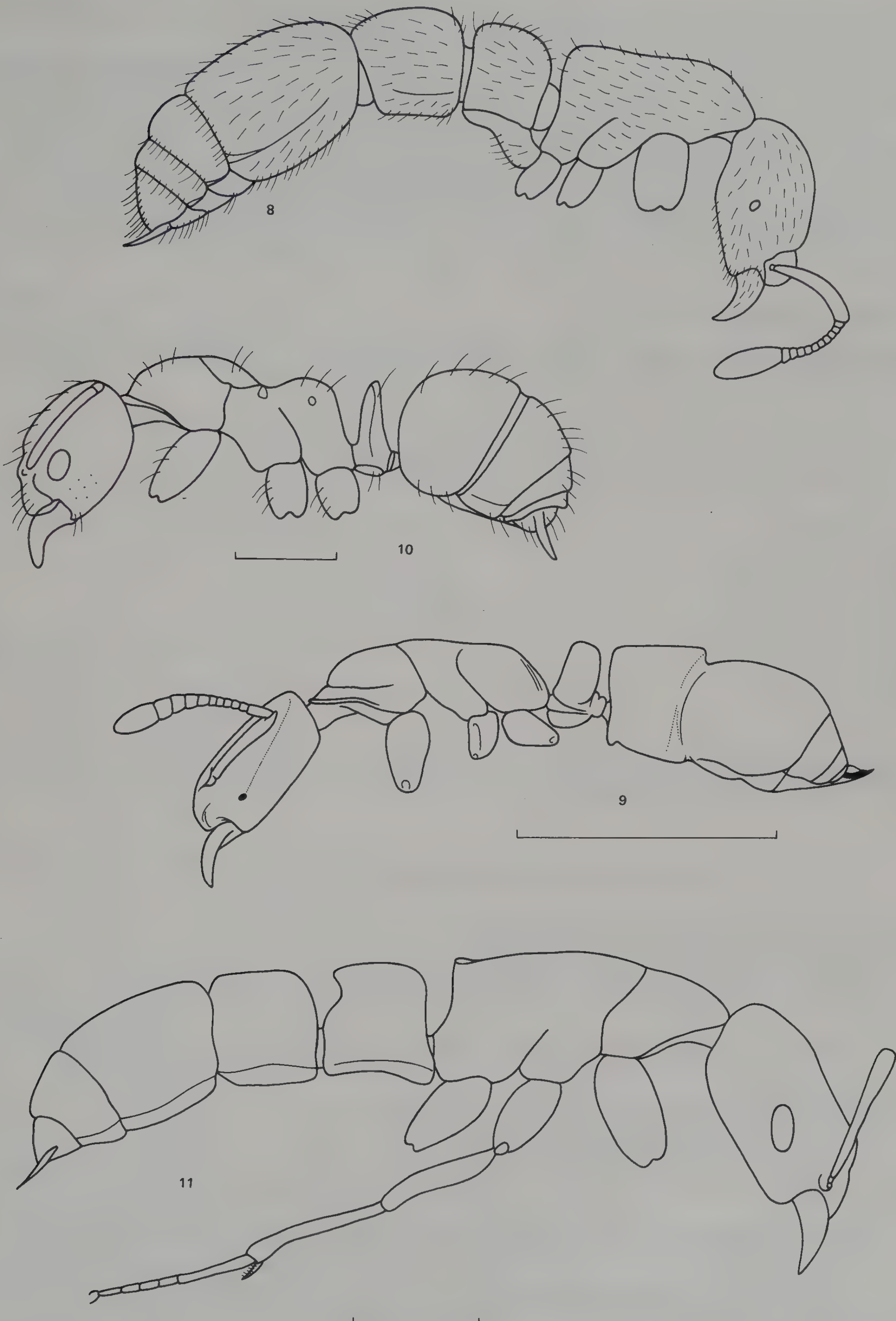
## Subfam. **Pseudomyrmecinae**

## Genus *Tetraponera* Smith

### *Tetraponera bifoveolata* Mayr, 1895 (fig. 15)

*Tetraponera bifoveolata* Mayr, 1895; Annln. naturh. Mus. Wien *10:* 146.

Al Fresh 20.IV.79; Turabah 20.III.80; Wadi Sanakah 25.IX.80; Wadi Ibrahim 27.III.82; ☿☿ W.




Figs 8–11: Profile view. 8, *Cerapachys wittmeri* ☿; 9, *Hypoponera punctatissima* ☿; 10, *Pachycondyla senaarensis* ☿; 11, *Platythyrea modesta* ☿. (Scale bar 1 mm).

Büttiker. Fayfa 29.III.83; Riyadh Agricultural Centre 19.IV.83; Al Qahman mangrove swamp 1.IV.83; river valley near Abha 25.III.83; Hofuf date palms 13.IV.83; ☿☿ CAC.

Species of this genus are arboreal living in small colonies in hollow twigs and foraging singly on branches. The samples collected closely resemble series from Palestine sent by J. Oefer and probably are referable to the form *T. bifoveolata* ssp. *syriaca* Wheeler, 1916. A single worker taken at Fayfa 30.III.83 has a distinct black blotch on the frons as in named samples of *T. bifoveolata* ssp. *maculifrons* Santschi, 1912 but are not otherwise distinguishable from the above. *T. bifoveolata* in NHMB has a flatter dorsal outline of the alitrunk and more numerous body hairs but the extent of variability in these various forms has not been studied sufficiently to justify species separation for the present.

***Tetraponera erythraea*** Emery, 1895

This was described by Emery (1895) from Aden in South Arabia. Examples in NHMB have the propodeum obtusely angled and not smoothly rounded as in *T. bifoveolata*.

## Subfam. **Dolichoderinae**

| List of species: | Geographical distribution: |
|---|---|
| *Tapinoma melanocephalum* (Fabricius) | Cosmopolitan |
| *Tapinoma simrothi* Krausse | North Africa, Middle East, South Europe |
| *Technomyrmex albipes* (Smith) | Middle East, Palaeotropics |
| *Technomyrmex setosus* n. sp. | Arabia |
| *Technomyrmex* sp. A | |
| *Technomyrmex* sp. B | |

These are small pale brown to black species nesting in soil or rotten wood. *T. melanocephalum* is a frequent household pest in the tropics.

### Key to species *(Tapinoma* and *Technomyrmex)*

| | | |
|---|---|---|
| 1. | Body colour uniformly dark brown to black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 2 |
| – | Bicoloured or yellowish brown species . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 3 |
| 2.(1) | Front border of clypeus with a slit-like cleft; legs including tarsi uniformly brownish ***simrothi*** Krausse | |
| – | Front border of clypeus with a shallow, rounded incision; tarsi very pale contrasting with darker tibiae ***albipes*** (Smith) | |
| 3.(1) | Head in part or gaster dark, contrasting with rest of body . . . . . . . . . . . . . . . . . . . . . . . | 4 |
| – | Entire body and legs unicolorous pale brown . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 5 |
| 4.(3) | Gaster dark contrasting with yellowish mid body; alitrunk with scattered dorsal hairs ***setosus*** n. sp. | |
| – | Gaster and most of alitrunk unicolorous pale; alitrunk without dorsal hairs; head sides with dark patches ***melanocephalum*** (Fabricius) | |
| 5.(3) | Front femora enlarged; funiculus segments 2–5 quadrate; scape not reaching occipital border; eyes x 0.15 HL ***Technomyrmex*** sp. A | |
| – | Front femora not enlarged; funiculus segments elongate; scape surpassing occipital border; eyes x 0.34 HL ***Technomyrmex*** sp. B | |

## Genus *Tapinoma* Foerster

### ***Tapinoma melanocephalum*** (Fabricius, 1793)

*Formica melanocephala* Fabricius, 1793; Ent. Syst. *2:* 353.

*Tapinoma melanocephalum* (Fabricius) Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 651.

Hofuf 11.IV.78; 1 ♂ W. Büttiker. Al Qatif 1980; ☿☿ Shaker M. Hammad. Al Qatif 14.IV.83; ☿☿ CAC. Oman: Wahiba sands XII.84; ☿ M. Gallagher.

This common cosmopolitan species was found nesting in the rotting leaf bases of date palms at Al Qatif. It is a common household pest in Africa.

### ***Tapinoma simrothi*** Krausse, 1909

*Tapinoma simrothi* Krausse, 1909; Bull. Soc. ent. ital. *41:* 18.

Al Qatif 15. IV.83; 1 ♀ CAC. Kuwait III.84; ☿☿ R.W. Service. Oman: Wahiba sands 17.XI.84; ☿☿ M. Gallagher.

A single queen was seen flying on to a leafy shrub. Shortly after, probably the same individual but now wingless, was recovered from the ground nearby. This species is abundant in the Middle East and locally common also in North Africa and parts of South Europe. It is an active daytime scavanger and also tends Homoptera on shrubs.

## Genus *Technomyrmex* Mayr

### ***Technomyrmex albipes*** (Smith, 1862)

*Formica (Tapinoma) albipes* Smith, 1862; J. Proc. Linn. Soc. Zool. *6:* 38.

*Technomyrmex albipes* (Smith) Emery, 1888; Z. wiss. Zool. *66:* 392.

Al Qatif 14.IV.84; 1 ♂ CAC.

This is a distinctive dark species with pale tarsi and funiculus segments. It occurs widely through the Indian subcontinent and Africa but occurs more locally in the Middle East.

### ***Technomyrmex setosus*** n. sp. (fig. 12)

Wadi Shugub 7.IV.83; Bishah 8.IV.83; ☿☿ CAC.

This is a bicoloured species having the head in part and the entire gaster dark, contrasting with the paler testaceous alitrunk. The propodeum is relatively low with a shallow metanotal furrow. The head, alitrunk and gaster bear scattered dorsal hairs. Workers were found under stones in the Asir mountains.

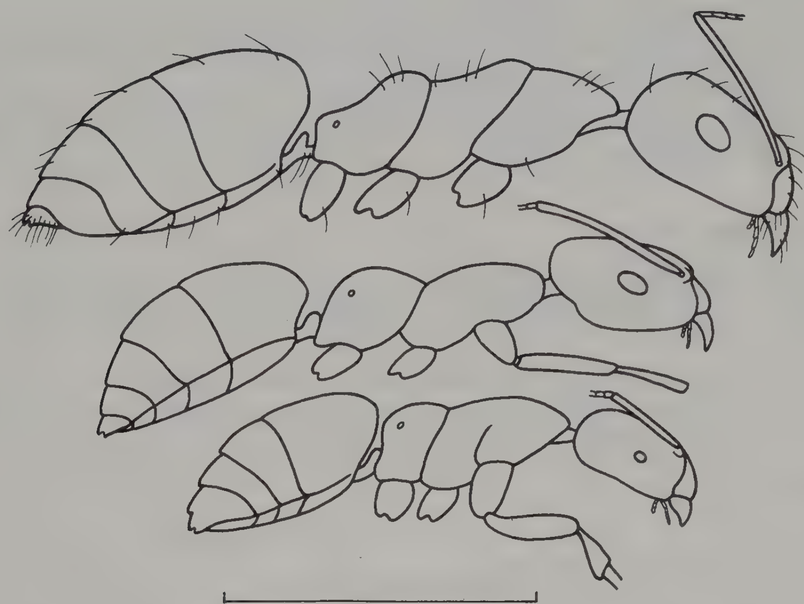
Holotype worker: TL 2.9; HL 0.73; HW 0.66; SL 0.73; EL 0.17; PW 0.43; CI 84.5; SI 109; EI 28.

The head is longer than wide, much wider than the alitrunk. The clypeus is widely emarginate. The mandibles are strongly toothed with the third and sixth teeth shorter than the fourth and seventh respectively. The antennal scape overreaches the occipital margin by the length of the first funiculus segment. All funiculus segments are elongate. The maximum eye length is about a quarter the head length.

The propodeum is widely excavated at its posterior basal face. The propodeal dorsum is rather flat, curving smoothly to the rather shallow metanotal furrow. The head is in part brown and the gaster entirely dark contrasting with the paler testaceous alitrunk and appendages.

The gaster has very fine granulose sculpture while the head and alitrunk are finely striate and rugose giving the whole body a somewhat dull appearance. Scattered dorsal hairs are present on the head, pronotum, propodeum and gaster.

Holotype and paratypes from Wadi Shugub 7.IV.83 are in the NHMB. Paratype workers similar to the holotype were also found at Bishah.




Figs 12–14: Profile view. 12, *Technomyrmex setosus* ☿; 13, *Technomyrmex* sp. A ☿; 14, *Technomyrmex* sp. B ☿. (Scale bar 1 mm).

***Technomyrmex*** sp. A (fig. 13)

Fayfa 28.III.83; ☿☿ CAC.

This ant was found inhabiting the trunk of a partly rotten roadside tree. This is a small species, TL 1.75; the body sculpture is finely granulose giving an opaque appearance; the head, alitrunk and gaster are pale yellowish brown. No dorsal hairs are visible on the head and alitrunk. The scape is short just reaching the occipital margin. The mandibles are broadly rounded. The anterior clypeal border has a shallow rounded median incision. The front femora and tibiae are markedly enlarged possibly as an adaptation to an arboreal habitat.

***Technomyrmex*** sp. B (fig. 14)

Al Farrash 15.X.82; ☿☿ W. Büttiker.

This is similar in colour to the previous species being pale yellowish brown with superficial punctulate sculpture. There are no dorsal hairs on the head or alitrunk. It differs in the relatively long antennae and larger eyes. It differs from the widely distributed *T. gibbosus* Wheeler and other similar species in the longer antennae. TL 2.2; HL 0.52; HW 0.52; SL 0.62; EL 0.16; SI 119.

Both the above species may well prove to be new but this cannot be confirmed without an up to date revision of the genus.

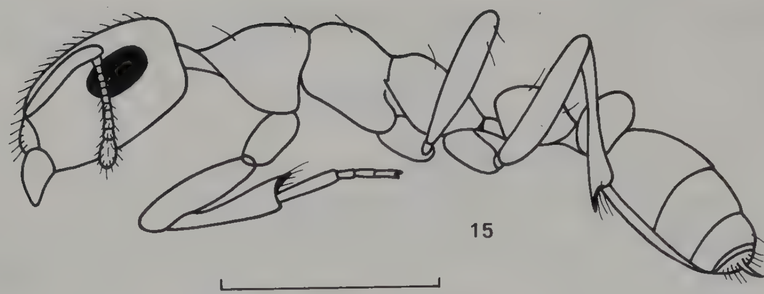
## Subfam. **Myrmecinae**

### Key to genera

| | | |
|---|---|---|
| 1. | Alitrunk fusiform without dorsal sutures . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 2 |
| – | Alitrunk with at least a metanotal suture or groove . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 3 |
| 2.(1) | Antennae 6 segmented, the two apical segments forming a club. Body hairs simple ***Melissotarsus*** Emery | |
| – | Antennae with 12 segments (in a few species 10 or 11), the three apical segments forming a club. Body hairs branched, in most species long and profuse ***Triglyphothrix*** Forel | |
| 3.(1) | Postpetiole attached mediodorsally to first gaster tergite; gaster cordiform from above ***Crematogaster*** Mayr | |
| – | Postpetiole attached medioventrally to first gaster segment; gaster pyriform from above . | 4 |
| 4.(3) | Antennae with 4 or 5 apical segments elongated and slightly enlarged to form a somewhat indistinct club . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 5 |
| – | Antennae with three apical segments enlarged to form a distinct club . . . . . . . . . . . . . . | 7 |
| 5.(4) | Antennae 11 segmented; eyes large pointed anteroventrally placed near mandible insertions ***Oxyopomyrmex*** André | |
| – | Antennae 12 segmented; eyes placed medially not near mandibles . . . . . . . . . . . . . . . . | 6 |
| 6.(5) | Mandibles broadly rounded. Most species polymorphic with head width increasing allometrically with increasing body size ***Messor*** Forel | |
| – | Mandibles triangular; monomorphic; head longer than broad ***Aphaenogaster*** Mayr | |
| 7.(4) | Clypeus longitudinally bicarinate; propodeum without spines or teeth ***Monomorium*** Mayr | |
| – | Clypeus with median portion rounded or flat; propodeum bituberculate or with spines or teeth . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 8 |
| 8.(7) | Clypeus raised into a ridge in front of antennal insertions ***Tetramorium*** Mayr | |
| – | Clypeus not raised into a ridge in front of antennal insertions . . . . . . . . . . . . . . . . . . . . | 9 |
| 9.(8) | Dimorphic species; major workers have greatly enlarged incavate heads with broad three toothed mandibles. Minor workers have narrow heads and large triangular multidentate mandibles ***Pheidole*** Westwood | |
| – | Monomorphic species; all workers in a colony of more or less even size and shape having mandibles of 5 teeth . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 10 |
| 10.(9) | Postpetiole enlarged, cordiform from above, in most species wider than long. Body hairs absent or few ***Cardiocondyla*** Emery | |
| – | Postpetiole not conspicuously enlarged, not wider than long. Body hairs present over whole dorsum ***Leptothorax*** Mayr | |

## Genus ***Oxyopomyrmex*** André

This genus includes about a dozen species with a restricted distribution from Greece to Spain in South Europe and the Middle East through North Africa to Tenerife. Species of this genus nest in open ground usually in sandy soil and like many small ants living in dry habitats often appear on the surface in some numbers after rain but are otherwise inconspicuous. The female castes are characterised by their large pointed eyes, eleven segmented antennae and strong development of long curved gula hairs.



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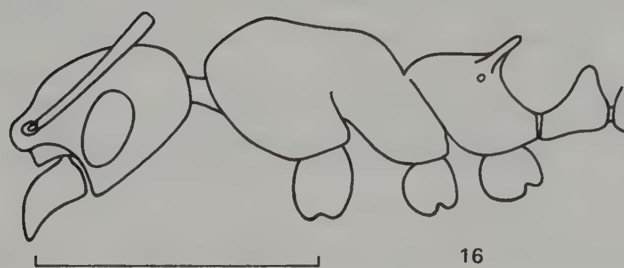

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Figs 15, 16: 15, *Tetraponera bifoveolata* ☿, profile view; 16, *Oxyopomyrmex sabulonis* ☿, head in profile view. (Scale bar 1 mm).

***Oxyopomyrmex sabulonis*** Santschi, 1926 (fig. 16)

*Oxyopomyrmex sabulonis* Santschi, 1926; Bull. Soc. Hist. nat. Afr. N. *17:* 233.

Al Kola 10.IV.83; ☿☿ CAC.

Only two workers were seen foraging separately over dry pasture. The head and alitrunk are coarsely sculptured and the body colour uniformly blackish brown. The species is recorded from North Africa.

## Genus *Aphaenogaster* Mayr

This genus includes a number of species groups of diverse form but mainly characterised by relatively long heads, large triangular strongly dentate mandibles and antennae which have the ultimate four or five segments elongate and slightly swollen to form a more or less distinct club. Many species are in part active predators on other insects.

***Aphaenogaster muschtaidica*** Ruzsky, 1905 n. stat. (fig. 17)

*Aphaenogaster gibbosa* ssp. *muschtaidica* Ruzsky, 1905; Formic. Imp. Rossici *1:* 719.

*Aphaenogaster gibbosa* ssp. *muschtaidica*. – Arnoldi, 1976; Zool. Zh. *15:* 1020, 1024.

This has the general shape, sculptured head and smooth shining gaster of *A. gibbosa* (Latreille) of West Europe but the body colour is brown rather than black, the legs are yellowish brown, the scape and funiculus segments are slightly shorter and thicker and the propodeal spines are shorter. Comparative indices for the two species comparing an example of *A. gibbosa* from France of equivalent size are as follows.

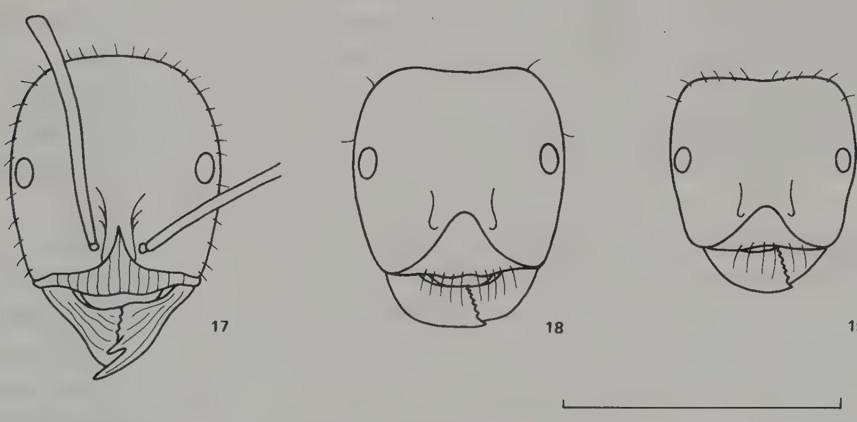
*A. muschtaidica* CI 83.3; SI 76.4; Spine length/HW 0.109.

*A. gibbosa* CI 85.2; SI 82.7; Spine length/HW 0.134.

These differences are in accord with recent descriptions and keys by Arnoldi 1976, and justify a species rather than subspecies distinction. *A. muschtaidica* was described from the Caucasus mountains of South Russia and is an interesting addition to the Arabian fauna. Named specimens but not types have been examined.

## Genus ***Messor*** Forel

| List of species: | Geographical distribution: |
|---|---|
| *Messor aralocaspius* (Ruzsky, 1902) | South east Europe |
| *Messor arenarius* (Fabricius, 1787) | Middle East, North Africa |
| *Messor buettikeri* n. sp. | Saudi Arabia |
| *Messor decipiens* Santschi, 1917 | South and East Africa |
| *Messor ebeninus* Santschi, 1927 | Middle East |
| *Messor galla* (Mayr, 1904) | North east to West Africa |
| *Messor mediorubra* Cagniant, 1969 | North Africa |
| *Messor meridionalis* (André, 1882) | Central Asia, Middle East |
| *Messor minor* (André, 1882) | North Africa, South Italy |
| *Messor orientalis* (Emery, 1896) | Middle East, South east Europe |
| *Messor picturatus* Santschi, 1923 | North Africa |
| *Messor rufotestaceus* (Foerster, 1850) | North Africa, Middle East |
| *Messor semirufus* (André, 1882) | Middle East |
| *Messor striaticeps* (André, 1882) | North Africa |
| *Messor syriacus* Santschi, 1927 | Middle East |




Figs 17–19: Head in dorsal view. 17, *Aphaenogaster muschtaidica* ☿; 18, *Messor picturatus* ☿; 19, *M. mediorubra* ☿. (Scale bar 1 mm).

*Messor* includes a number of mainly granivorous species. Nearly all the species in arid regions bear an arangement of well developed curved gula hairs or psammophore. The large headed major workers have broad strong mandibles adapted for crushing seeds. Most species forage in files to and from a seed source. In Arabia sorghum is often utilised as a source of food and sorghum fields may suffer some localised seed loss around the field perimeter.

## Key to species (large workers)

| | | | |
|---|---|---|---|
| 1. | Gula with short moderately curved or straight hairs | | 2 |
| – | Gula with long anteriorly curved hairs forming a distinct psammophore | | 3 |
| 2.(1) | Strongly sculptured robust brown or blackish brown species. Propodeum angulate to broadly dentate | ***orientalis*** (Emery) | |
| – | Smooth shining slender bicoloured species with reddish yellow head and alitrunk contrasting with dark gaster. Propodeum with small teeth | ***rufotestaceus*** (Foerster) | |
| 3.(1) | First funiculus segment not longer than second; all tibial spurs pectinate. Propodeum with distinct spines or teeth | ***arenarius*** (Fabricius) | |
| – | First funiculus segment distinctly broader and much longer than second; mid and hind tibial spurs simple. Propodeum rounded, angulate or broadly dentate | | 4 |
| 4.(3) | First gaster tergite conspicuously hairy with long pale hairs | | 5 |
| – | First gaster tergite with few short hairs or none | | 7 |
| 5.(4) | Head red or dark red contrasting with dark brown alitrunk and gaster | ***decipiens*** Santschi | |
| – | Unicolorous black or brownish black species | | 6 |
| 6.(5) | Maximum head width less than 2 mm; eyes large, 0.25 × HW | ***buettikeri*** n. sp. | |
| – | Maximum head width 2.5 mm; eyes 0.2 × HW | ***aralocaspius*** (Ruzsky) | |
| 7.(4) | Unicolorous black | | 8 |
| – | Bicoloured species with head or alitrunk or both reddish, contrasting with darker gaster | | 9 |
| 8.(7) | Propodeum dentate; head closely sculptured with fine striae | ***striaticeps*** (André) | |
| – | Propodeum angled but never dentate; head smooth and shining | ***ebeninus*** Santschi | |
| 9.(7) | Head and gaster darker than alitrunk | | 10 |
| – | Head and alitrunk red or brownish red contrasting with dark gaster | | 12 |
| 10.(9) | Eyes large 0.26 × HW; propodeum rounded; head width <1.5 mm | ***syriacus*** Santschi | |
| – | Eyes smaller 0.21–0.22 × HW; propodeum angulate; head width >1.5 mm | | 11 |
| 11.(10) | First gaster tergite with some short erect hairs; occiput with at least 6 projecting hairs on each side of occipital impression. Maximum head width less than 2 mm | ***mediorubra*** Cagniant | |
| – | First gaster tergite hairless; occiput with 3 hairs or fewer on each side of median impression. Maximum head width 2.5 mm or more | ***meridionalis*** (André) | |
| 12.(9) | Maximum head width 2.5 mm or more | | 13 |
| – | Maximum head width 2.0 mm or less | | 14 |
| 13.(12) | Head and alitrunk bright yellowish red | ***semirufus*** (André) | |
| – | Head wine red or brownish red, alitrunk often darker | ***galla*** (Mayr) | |
| 14.(12) | Head bright red, occiput smooth; scape hairs subdecumbent | ***minor*** (André) | |
| – | Head and alitrunk brownish red; dorsum of head completely sculptured to occiput; scape hairs suberect | ***picturatus*** Santschi | |

***Messor aralocaspius*** (Ruzsky, 1902) (fig. 20)

*Aphaenogaster barbara* var. *aralocaspius* Ruzsky, 1902; Ants of Lake Aral; 20.

*Messor aralocaspius* (Ruzsky) Pisarski, 1967; Annls. zool. Warsz. *24:* 384.

Al Ula 21.IV.79; ☿ KAU NHMB expedition. Wadi Khumra 10.II.78; Thanomah 2150 m 10.IV.80; Anamas 8.IV.80; Shafah III.82; An Naamah 2000 m 12.IX.83; ☿☿ ♀♀ W. Büttiker. Zahran 25.III.83; Anamas 8.IV.83; Tanuma 8.IV.83; Al Kola 10.IV.83; ☿☿ CAC. Kuwait 17.III.81; ☿ R.W. Harkness.

This species was found mainly on the Asir highlands. The Arabian samples closely resemble named examples from South Russia. They have long, pale body hairs distributed evenly but not thickly over all dorsal surfaces and long curved gula hairs forming a distinct psammophore.

***Messor arenarius*** (Fabricius, 1787)

*Formica arenaria* Fabricius, 1787; Mant. Insect. *1:* 310.

*Messor arenarius* (Fabricius) Forel, 1890; C.R. Soc. ent. Belg. *34:* 70.

Al Qatif 14.IV.83; 1 ☿ CAC. Kuwait: Sulei Bihat III.81; 1 ☿ R.W. Harkness.

This large North African/Middle East species is an inhabitant of sandy desert margins. It is characterised by its strong sculpture and well developed propodeal spines. Unlike the majority of *Messor* species, workers tend to forage singly or in small groups and do not form distinct trails.

***Messor buettikeri*** n. sp. (fig. 22)

Wadi Khumra 10.II.78; Khashm Khafs 25.I.81; ☿☿ ♂♂ ♀♀ W. Büttiker.

This small black species is linked to *M. syriacus* by the large eye size and rounded propodeum but from the pilosity and colour, not the sculpture, it resembles *M. bodenheimeri* Menozzi. It differs from small individuals of *M. aralocaspius* by the propodeum which in that species is distinctly angulate and which also differs by the transversely rugulose promesonotum, more sculptured head and smaller eyes, 0.2 or less x HW.

Holotype worker, paratype workers, males and queens from Wadi Khumra. Paratype queens from Khashm Khafs.

Holotype worker: TL 6.1; HL 1.35; HW 1.30; EL 0.33; SL 1.15; SI 88.4.

In full face, the head is nearly square, straight sided with the occipital margin feebly emarginate. The propodeum is smoothly rounded in profile, the petiole broadly angulate. The mandibles are longitudinally striate. Striae on the head are restricted to the anterolateral area, clypeus, lower frons and around the antennal insertions. The promesonotum is confusedly longitudinally rugulose, the propodeum laterally striate with wide interspaces. The gaster is smooth and the whole body brilliant black with paler appendages. All dorsal surfaces have long pale hairs, the gula hairs forming a distinct psammophore. In full face hairs project all round the occiput and genae to the mandible insertions.

Paratype queen: TL 9.75; HL 1.75; HW 1.9; EL 0.5; SL 1.6. Pilosity and colour as worker; mesonotum and scutellum smooth.

Paratype male: TL 8.05; HL 1.4; HW 1.15.

Mesonotum diagonally striate each side of the mid line; scutellum smooth. Very long hairs are present on all surfaces including the antennae.

Holotype and paratypes in NHMB.

***Messor decipiens*** Santschi, 1917

*Messor capensis* st. *decipiens* Santschi, 1917; Bull. Soc. Hist. nat. Afr. N. *8:* 94.

*Messor decipiens*. – Bolton, 1982: 348.

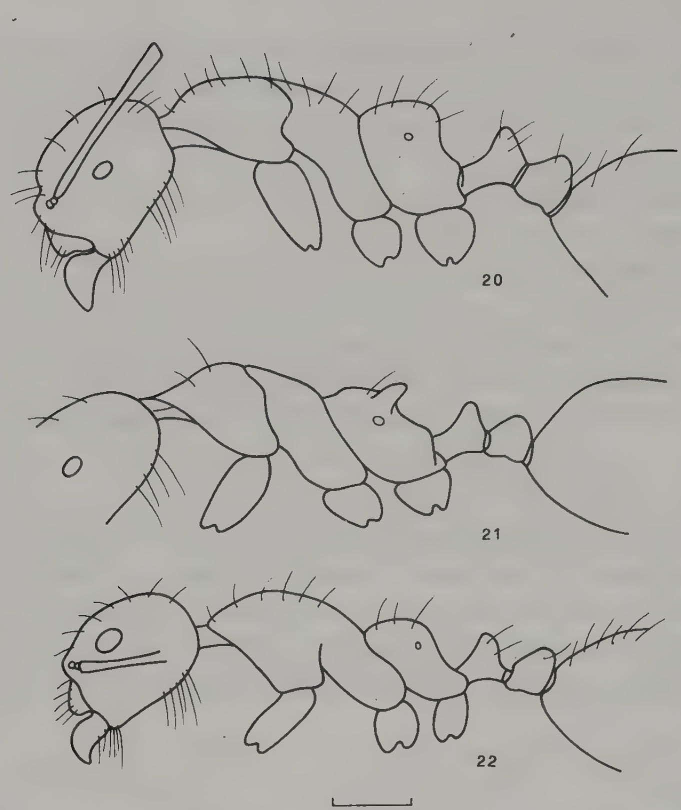
Anamas 2000 m 8.IV.83; ☿☿ CAC.

These red headed workers have very similar pilosity to samples identified as *M. aralocaspius* above. However the ants are somewhat larger and correspond well with the description of Bolton (1982). *M. decipiens* is recorded from South and East Africa.

***Messor ebeninus*** Santschi, 1927

*Messor barbarus* ssp. *semirufa* var. *ebenina* Forel, 1910; Annls. Soc. ent. Belg. *54:* 10.

*Messor semirufus* var. *ebeninus* Santschi, 1927; Boln. Soc. esp. Hist. nat. *27:* 229.



Figs 20–22: Profile view. 20, *Messor aralocaspius* ☿; 21, *M. striaticeps* ☿; 22, *M. buettikeri* ☿. (Scale bar 1 mm).

*Messor ebeninus.* – Tohmé, 1970; Bull. Soc. ent. Egypte *54:* 569–570.

Riyadh 2.I.76; Quwayiyah 3.III.78; Bakhara 16.II.80; Wadi Daykah 4.IV.80; Khashm Khafs 23.I.81; ☿☿ ♀ W. Büttiker. Riyadh 16.I.80; ☿☿ A.S. Talhouk. River valley near Abha 25.III.83; Wadi Kust 7.IV.83; Fayfa 27.III.83; 30.III.83; Shaqiq Shamron Juniperus bank 8.IV.83; desert outside Riyadh 12.IV.83; Al Qatif cultivated ground 14.IV.83; ☿☿ ♀♀ CAC.

This is a common black Middle East species known to occur in Lebanon, Iran, Iraq, Palestine and Syria and was the most abundant species seen in Saudi Arabia living in large colonies in open ground usually but not always adjacent to cultivated ground. This species has the head and gaster smooth and shining with only an occasional hair on the first gaster tergite and up to six hairs on each side of the occipital margin. The alitrunk has rugulose sculpture and the propodeum is smoothly angulate without teeth.

### *Messor galla* (Mayr, 1904)

*Stanamma (Messor) barbarum* var. *galla* Mayr, 1904; in Jaegerskjoeld, Swed. Zool. Exp. Egypt & White Nile *1* (6): 5.
*Messor galla* (Mayr) Santschi, 1928.

Fayfa village cultivated ground 1.IV.83; ☿☿ CAC.

This large red headed species has a wide distribution across the Sahelian zone of tropical Africa and has been recorded from several Northeastern and East African countries south of Egypt. It has some resemblance to *M. semirufus* of the Middle East but is of a darker colour with a very different geographical distribution.

***Messor mediorubra*** Cagniant, 1969 (fig. 19)

*Stenamma barbarum* r. *capitatus* var. *mediorubra* Forel, 1905; Annls. Soc. ent. Belg. *49:* 176.

*Messor mediorubra* Cagniant, 1969; Bull. Soc. Hist. nat. Toulouse *105:* 415.

Wadi Khumra 10.II.78; ☿☿ W. Büttiker.

This is a bicoloured North African species similar to *M. meridionalis* in general appearance and size but differing by the presence of more numerous hairs on the occiput and a variable number of hairs on the first gaster tergite.

***Messor meridionalis*** (André, 1882)

*Aphaenogaster barbara* var. *meridionalis* André, 1882; Spec. Hym. Europe *2:* 353.

*Messor meridionalis* (André) Bondroit, 1918; Annls. Soc. ent. Fr. *87:* 155.

Kuwait III.78; ☿ K. Dumpert. Kuwait 17.III.81; ☿ R.W. Harkness.

This is a Central Asian species extending westward into the Middle East (Iran, Iraq, Lebanon, Syria).

***Messor minor*** (André, 1882)

*Aphaenogaster barbara* var. *minor* André, 1882; Spec. Hym. Europe *2:* 355.

*Messor minor* (André) Kutter, 1927; Folia Myrm. et Term. *1:* 99.

Wadi Qust 7.IV.83; Al Tawlah 7.IV.83; ☿☿ CAC.

This small bright red headed species occurs in North Africa and Italy. Two small colonies were seen on the Asir highlands.

***Messor orientalis*** (Emery, 1896)

*Stenamma (Messor) structor* var. *orientalis* Emery, 1896; Öfvers. finska Vetensk Soc. Förh. *29:* 20.

*Messor orientalis* (Emery) Collingwood, 1960; Vidensk. Meddr. dansk naturh. Foren *123:* 62.

Yemen: Sana El Errein XI.37; ☿ C. Rathjens BMNH.

This was not seen during the 1983 expedition. It is the largest species of the *M. structor* (L.) species group from which it is distinguished by the major workers which have a clearly angulate or dentate propodeum. It is recorded from Central Asia, South east Europe and the Middle East.

***Messor picturatus*** Santschi, 1923 n. stat. (provisional) (fig. 18)

*Messor barbarus* st. *minor* var. *picturata* Santschi, 1921; Bull. Soc. Hist. nat. Afr. N. *12:* 69.

*Messor instabilis* ssp. *picturata* Santschi, 1923; Revue suisse Zool. *30:*

Wadi Khumra 10.II.78; ☿☿ W. Büttiker. Riyadh Agricultural Centre 18.IV.83; ☿☿ CAC.

This is similar in colour, head shape and sculpture to *M. instabilis* (Smith) of the Indian subcontinent but differs in having no dorsal hairs on the first gaster tergite and few very short hairs or none on the occiput. The Arabian examples closely match named specimens in the NHMB collection from North Africa and this form is probably a good species, clearly separable on pilosity characters from *M. instabilis.*

***Messor rufotestaceus*** (Foerster, 1850)

*Myrmica rufotestacea* Foerster, 1850; Verh. naturh. Ver. preuss. Rheinl. *7:* 489.

*Messor rufotestaceus* (Foerster) Emery, 1908; Dt. ent. Z. (1908): 437.

Wadi Qust 7.IV.83; 1 ☿ CAC.

A single worker of this pale shining slender species was found foraging in the early morning on stony ground but no colony was traced. This species is distinguished by the slender antennae, alitrunk and nodes and has short erect hairs evenly distributed all over the body.

***Messor semirufus*** (André, 1882)

*Aphaenogaster barbara* var. *semirufa* André, 1882; Spec. Hym. Europe *2:* 355.
*Messor semirufus* (André) Santschi, 1927; Boln. Soc. esp. Hist. nat. *27:* 232.

Summer Plateau, 1930; ☿ H. Scott & E.B. Sutton.

A specimen so named was seen in the BMNH collection some years ago. It is one of the commoner Middle East species but is not known to occur in North Africa. The species may be distinguished from the similar *M. galla* by the generally lighter colour, the finely reticulate sculpture of the gaster dorsum and the occasional dorsal hairs on the first tergite.

***Messor syriacus*** Santschi, 1927

*Messor laboriosa* var. *syriacus* Santschi, 1927; Boln. Soc. esp. Hist. nat. *27:* 240.
*Messor syriacus*. – Tohmé & Tohmé, 1981: 145.

Al Khubra 29.V.78; ☿☿ W. Büttiker. Desert near Hofuf 12.IV.83: ☿☿ CAC.

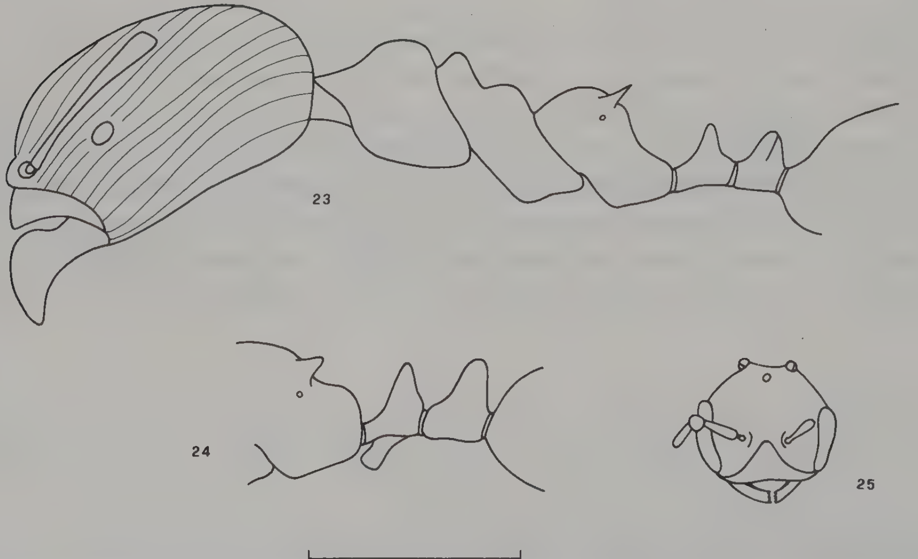
This is one of the smaller *Messor* species. The reddish alitrunk contrasts with the dark head and gaster; the propodeum is smoothly rounded; the eyes are comparatively large, x 0.26 HW; the head bears long dorsal and gula hairs. These features ally the species with *M. rugosus* (André) but the sculpture is much smoother. According to TOHMÉ & TOHMÉ 1981, *M. syriacus* is the commonest *Messor* species in Syria.

***Messor striaticeps*** (André, 1882) (fig. 21)

*Aphaenogaster barbara* var. *striaticeps* André, 1882; Spec. Hym. Europe *2:* 356.
*Messor striaticeps* (André) Cagniant, 1969; Bull. Soc. Hist. nat. Toulouse *105:* 415.

Al Qatif 15.IV.83; ☿☿ CAC.

This closely sculptured black species with dentate propodeum was found foraging in sandy terrain adjacent to date palm and vegetable cultivation. It is a North African species not known to occur in the Middle East.




Figs 23–25: 23, *Pheidole teneriffana* ☿, profile view; 24, *Ph. lamellinoda* ☿, part profile; 25, *Ph. megacephala* ☿, head in dorsal view. (Scale bar 1 mm).

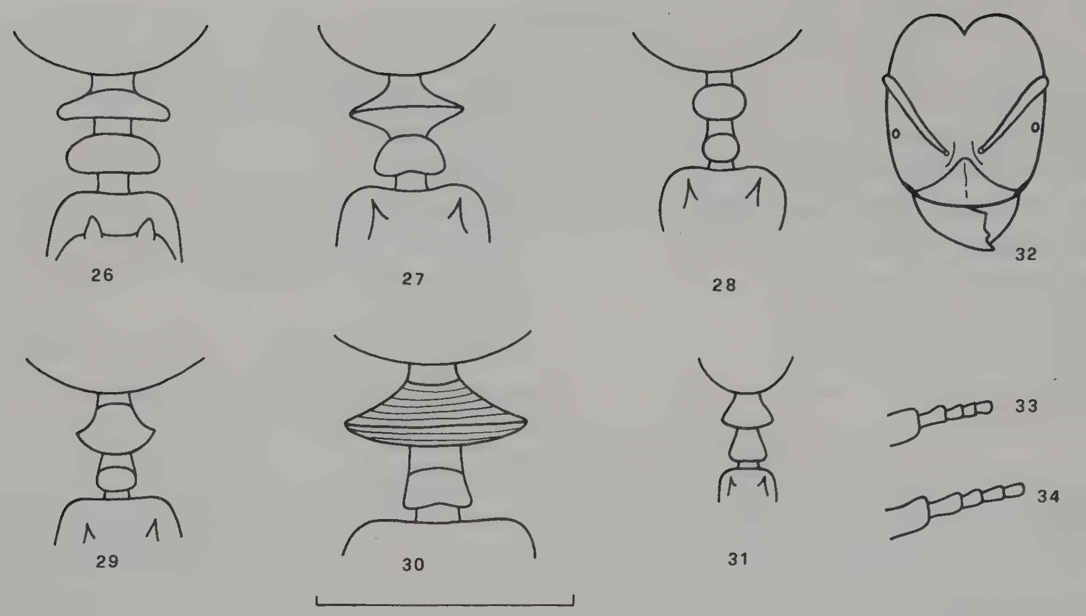
## Genus *Pheidole* Westwood

| List of species: | Geograhical distribution: |
|---|---|
| *Pheidole jordanica* Saulcy, 1874 | Middle East |
| *Pheidole lamellinoda* Forel, 1802 | West India |
| *Pheidole megacephala* (Fabricius, 1793) | Africa, tropicolopitan |
| *Pheidole minuscula* Bernard, 1951 | North west Africa |
| *Pheidole rugaticeps* Emery, 1877 | North east Africa, Arabia |
| *Pheidole sculpturata* Mayr, 1862 | Tropical Africa |
| *Pheidole sinaitica* Mayr, 1862 | North Africa, Egypt |
| *Pheidole teneriffana* Forel, 1893 | North Africa, Middle East, Teneriffe |

The workers are of two sizes in this genus. The major workers have very large heads with expanded occipital lobes and are much bigger over all than the narrow headed minor workers. Since the major workers with their exaggerated structures show much clearer discriminatory characters in form and sculpture compared with minor workers, all workable keys are based on the former. There are a large number of described forms on the African continent but considerably fewer in the Middle East. Most species are scavangers and predators and will assemble readily to any form of edible bait. The tropicopolitan *Pheidole megacephala* is often a household pest. Males of this genus, recognisable by their short antennal scapes and strongly protuberant ocelli, are often caught at light traps.

### Key to species (large workers)

| | | |
|---|---|---|
| 1. | HW less than 1 mm; head rectangular clearly longer than wide **minuscula** Bernard | |
| – | HW greater than 1.35 mm; head sides curved not or scarcely longer than broad ..... | 2 |
| 2.(1) | Petiole with ventral projection, in profile a translucent lobe **lamellinoda** Forel | |
| – | Petiole without a ventral projection .......... | 3 |
| 3.(2) | Postpetiole wider than long, distinctly dentate at widest point .......... | 4 |
| – | Postpetiole scarcely or not wider than long, at most slightly angled at sides ......... | 6 |
| 4.(3) | Promesonotal outline broken by distinct mesonotal ridge; funiculus segments 2, 3 and 4 longer than broad .......... | 5 |
| – | Promesonotal outline evenly curved without a distinct mesonotal prominence; funiculus segments 2, 3 and 4 not longer than broad **megacephala** (Fabricius) | |
| 5.(4) | Head completely striate to occiput; postpetiole about × 2 as wide as long **teneriffana** Forel | |
| – | Head with median occipital area smooth; postpetiole about × 3 as wide as long **sculpturata** Mayr | |
| 6.(3) | Larger species, HW greater than 2 mm; sides of head finely striate to occiput; first gaster tergite partially or totally striate **rugaticeps** Emery | |
| – | Smaller species, HW 1.6 mm or less; occipital lobes without striae; first gaster tergite smooth .......... | 7 |
| 7.(6) | Postpetiole longer than broad about 0.2 × HW; funiculus segment 2 scarcely longer than broad **jordanica** Saulcy | |
| – | Postpetiole about as wide as long, 0.23 × HW; funiculus segment 2 slightly longer than wide **sinaitica** Mayr | |



Figs 26–31: Petiole nodes in dorsal view. 26, *Pheidole lamellinoda* ☿; 27 *Ph. teneriffana* ☿; 28, *Ph. sinaitica* ☿; 29, *Ph. megacephala* ☿; 30, *Ph. sculpturata* ☿; 31, *Ph. minuscula* ☿. Fig. 32: *Ph. minuscula* ☿, head in dorsal view. Figs 33–34: First three funiculus segments. 33, *Ph. megacephala* ☿, 34, *Ph. sinaitica* ☿. (Scale bar 1 mm).

***Pheidole jordanica*** Saulcy, 1874 (figs 28, 34)

*Pheidole jordanica* Saulcy, 1874; Bull. Soc. Hist. nat. Moselle *13:* 17.

Al Qahman 1.IV.83; Al Tawlah 7.IV.83; Al Kola 10.IV.83; Al Kharfah 24.III.83; ☿☿ CAC.

This is a fairly common Middle East species that also occurs in North east Africa.

***Pheidole lamellinoda*** Forel, 1902 (figs 24, 26)

*Pheidole lamellinoda* Forel, 1902; Revue suisse Zool. *10:* 166.

Socotra: Adho Dimellus IV.67; ☿☿ K.M. Guichard.

This distinctive yellow species with a subpetiolar process in the form of a translucent projecting lamina is recorded from Central and Western India (Bingham 1903) but so far has not been reported from the African continent.

***Pheidole megacephala*** (Fabricius, 1793) (figs 25, 29, 33)

*Formica megacephala* Fabricius, 1793; Ent. Syst. *2:* 361.

*Pheidole megacephala* (Fabricius) Roger, 1863; Verz. Formicid.: 30.

Riyadh Agricultural Centre 7.VII.75; Hofuf 20.V.78; Wadi Qatan 26.IX.80; Turabah 7.X.80; Uqdah 26.VIII.83; ♂♂ ☿☿ ♀ W. Büttiker. Abha 4.IX.83; ☿☿ A.S. Talhouk. Al Kharfah 24.III.83; valley near Abha 25.III.83; Fayfa 27.III.83; Abu Arish 2.IV.83; Wadi Shugub 7.IV.83; Najran 10.IV.83; ♂♂ ☿☿ ♀♀ CAC.

This common cosmopolitan species occurred in a variety of habitats mainly in the south west.

***Pheidole minuscula*** Bernard, 1951 (figs 31, 32)

*Pheidole minuscula* Bernard, 1951; Mém. Inst. fr. Afr. noire *11:* 226.

Fayfa 31.III.83; Abu Arish resthouse grounds 2.IV.83; Al Qatif date palms 14.IV.83; ♂ ☿☿ ♀ CAC.

This was the smallest *Pheidole* species seen. The major workers have long rectilinear heads with only slight genal curvature. Head length to occipital corner 1 mm, width 0.84 mm. The clypeus is shining

with a raised central keel. The species is linked by its narrow head to the larger, darker *P. termitophila* Forel and to the more sculptured and still larger *P. liberiensis* Forel. BERNARD (1951) compared the three and described *P. minuscula* from Mt. Nimba in North west Africa, geographically remote from Arabia. All specimens were taken in leaf litter.

***Pheidole rugaticeps*** Emery, 1877

*Pheidole rugaticeps* Emery, 1877; Annali Mus. civ. Stor. nat. Giacomo Doria *9:* 375.

This was described from the Yemen by Emery but not yet found in Saudi Arabia. *P. rugaticeps* has the occiput with fine transverse striae and the first gaster tergite has fine punctulate sculpture and fine longitudinal striae.

Specimens of a *Pheidole* sp. from Oman kindly sent by Mr M. Gallacher correspond with the less sculptured form *P. rugaticeps* var. *arabs* Emery, 1881 described from Tes in Southern Arabia.

***Pheidole sculpturata*** Mayr, 1866 (fig. 30)

*Pheidole sculpturata* Mayr, 1866; Verh. zool.-bot. Ges. Wien *16:* 897.

Abu Arish resthouse grounds 25.III.83; Fayfa 27.III.83; Najran 10.IV.83; ☿☿ CAC.

This was the largest species of *Pheidole* found with the major worker head widths ranging from 2.2 mm up to 3 mm. The postpetiole is very wide and sharply angulate or dentate at the sides. The large heads are slightly longer than wide, clear red with longitudinal striae fading out on the occiput. A nest was found under a stone at Fayfa but at the other sites individual foragers were seen.

***Pheidole sinaitica*** Mayr, 1862

*Pheidole sinaitica* Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 745.

Fayfa 30.III.83; Najran 10.IV.83; ☿☿ CAC.

This species is similar to *P. jordanica* from which it differs only in slight details of body shape and sculpture. Forel recorded it as *P. sinaitica* var. *santschii* from Arabia (FOREL 1907: 204). It is otherwise recorded from North East Africa, Egypt and the Middle East.

***Pheidole teneriffana*** Forel, 1893 (figs 23, 27)

*Pheidole teneriffana* Forel, 1893; Annls. Soc. ent. Belg. *37:* 465.

Riyadh 2.I.76; Jeddah 25.III.75; Al Khardj 10.IV.78; Araida 9.X.75; Al Kharj 25.V.50; ♂♂ ☿☿ ♀ W. Büttiker. Riyadh 23.III.83; Al Kharj public park 23.III.83; ♂♂ ☿☿ ♀♀ CAC.

This is a well characterised species with a strongly striate head and a wide sculptured petiole. It is widely distributed and tending to become cosmopolitan, spreading around places of human settlement. Strong populous colonies were seen at Al Kharj and it is evidently a vigourous and successful species.

## Genus ***Melissotarsus*** Emery

This genus contains only three known species all of which are restricted to tropical Africa. The ants are small, 2.3–3.4 mm long, arboreal, living under the bark of live trees. Members of this genus have a short, thick box-like unsutured alitrunk; the middle and hind coxae as well as the basal tarsal segment of each leg are enlarged. DELAGE-DARCHEN (1972) showed that worker ants propel themselves forward by the front and hind legs with the mid legs held upward against the bark ceiling of the nest. BOLTON (1982), gives an updated revision of the genus.

***Melissotarsus emeryi*** Forel, 1908 (fig. 35)

*Melissotarsus emeryi* Forel, 1908; Revue Ent. (1908): 133.

Fayfa tamarisk grove 29.III.83; ♂♂ ☿☿ CAC.

A number of small colonies were found by scraping the bark of ancient tamarisk trees. In West Africa this species occurs high up on large forest trees and can only normally be discovered on felled trees. At Fayfa most of the few old tamarisk trees were in a state of partial collapse with part of their trunks lying horizontally.

This is an interesting record of what may be regarded as a relict species in a small remnant of old woodland. The nearest known records for this species are from Ethiopia and Sudan.

## Genus *Leptothorax* Mayr

This is a very large genus of small to medium sized ants, some of which are arboreal, living under bark, in twigs or in dead wood.

***Leptothorax angulatus*** Mayr, 1862 (fig. 36)

*Leptothorax angulatus* Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 739.

Thanomah 11.IV.80; Wadi Drady 1.V.80; Al Fresh 20.IV.79; Wadi Aridah 10.IX.83; ☿☿ W. Büttiker. Fayfa 21.III.83; 30.III.83; Al Tawlah 7.IV.83; Wadi Shugub 7.IV.83; 40 km east of Khamis Muschaid 10.IV.83; ♂ ☿☿ ♀♀ CAC.

This a widely distributed African species found throughout the continent and extending northward to the Middle East. Workers are yellowish brown with dark antennal clubs and have a superficial resemblance to some members of the genus *Tetramorium* having angled pronotal shoulders and thick petiole and postpetiole nodes. *L. angulatus* is the only species so far found in Arabia and was found mostly in old dead wood of Acacia.

## Genus *Cardiocondyla* Emery

| List of species: | Geographical distribution: |
|---|---|
| *Cardiocondyla emeryi* Forel, 1881 | Pantropical |
| *Cardiocondyla nuda* (Mayr, 1866) | Malaysia, India, North Africa |
| *Cardiocondyla schuckardi* Forel, 1891 | Tropical & subtropical Africa |
| *Cardiocondyla wroughtonii* (Forel, 1890) | Pantropical |
| *Cardiocondyla* sp. | Oman |

These are minute to small species 1.7–3.4 mm. Most live in the soil but some are also found nesting in the bark of old trees. Many of the species become distributed as tramp species over the warmer parts of the world through soil and plant material but do not reach the status of being glasshouse or household pests.

### Key to species (workers)

1. Propodeal spines very short and blunt .......... 2
– Propodeal spines distinct and acute .......... 3

2. Colour brownish to black; petiole as broad or broader than long **schuckardi** Forel
– Bicoloured with alitrunk paler than gaster; petiole longer than broad **nuda** (Mayr)
3.(1) Mesonotum steeply and abruptly descending to the metanotal groove; petiole node subglobular slightly broader than long **wroughtonii** (Forel)
– Mesonotum curving evenly to the metanotal groove; petiole oval, longer than broad . 4
4.(3) Propodeal dorsum distinctly convex in profile; propodeal spines short, very slightly longer than their basal width; Petiole in profile with flattened dorsum **emeryi** Forel
– Propodeal dorsum mildly convex, metanotal groove shallow, propodeal spines distinctly longer than their basal width; petiole in profile with rounded dome like dorsum ***Cardiocondyla*** sp.

### ***Cardiocondyla emeryi*** Forel, 1881

*Cardiocondyla emeryi* Forel, 1881; Mitt. münch. ent. Ges. *5:* 5.

Fayfa 28.III.83; 30.III.83; Hofuf 13.IV.83; 14.IV.83; ☿☿ ♀ CAC. Oman: Khabura III.79; 1 ♀ R.P. Whitcombe.

The Saudi Arabian samples were all taken in leaf litter in tree shade. The Oman specimen was extracted from the gut contents of a swift *(Apus pallidus)*. This is a widely distributed tramp species.

### ***Cardiocondyla nuda*** (Mayr, 1866)

*Leptothorax nudus* Mayr, 1866; Sber. Akad. Wiss. Wien, math.-naturw. Kl. *53:* 508.
*Cardiocondyla nuda* (Mayr) Forel, 1881; Mitt. münch. ent. Ges. *5:* 5.

Abu Arish resthouse grounds 3.IV.83; ☿☿ CAC.

Specimens were taken from grass litter beneath a hedge. This widespread oriental species has spread westward to the Middle East and North Africa.

### ***Cardiocondyla schuckardi*** Forel, 1891 (fig. 37)

*Cardiocondyla schuckardi* Forel, 1891; Grandidier Hist. Madagascar *20* (2): 161.

Al Kharj public park 23.III.83; Hair valley 17.IV.83; ☿☿ CAC Wadi Azizah 18.IX.83; ♀ W. Büttiker.

At Al Kharj, workers were excavating soil from a ground nest in a shady border. Foraging workers were taken singly along a river valley at Hair. The species is characterised by its relatively long antennal scapes, very reduced propodeal spines, globular petiole and generally dark colour. Previous records for this species are from sub-Saharan Africa (Bolton 1982).

### ***Cardiocondyla*** sp.

Oman: Wahiba sands 27.XI.84; ☿☿ M. Gallagher.

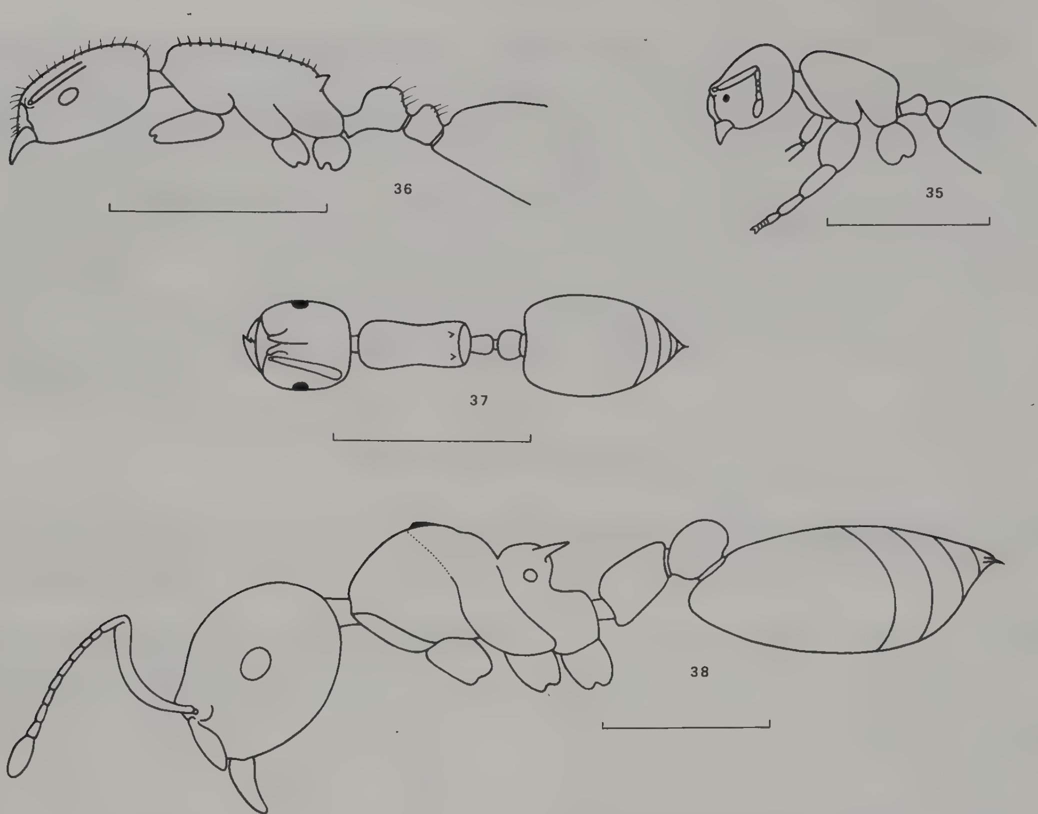
This has coarser punctulate head sculpture, longer spines, darker colour, flatter propodeal outline and a more domed petiole than *C. emeryi* and does not correspond with any of the species listed and described from the Afrotropics by Bolton 1982 and is probably an undescribed species.

### ***Cardiocondyla wroughtonii*** (Forel, 1890)

*Emeryia wroughtonii* Forel, 1890; Annls. Soc. ent. Belg. *34:* 101.
*Cardiocondyla wroughtonii* (Forel) Forel, 1892; Verh. zool.-bot. Ges. Wien *42:* 313.

Fayfa tamarisk grove 29.III.83; Fayfa 30.III.83; ☿☿ CAC.

This species was taken in bark crevices or foraging on old trees. It is known from the Middle East and East Africa but has a wide range as a tramp species from the Far East to the Americas. It is the smallest and palest of the species found in Arabia measuring less than two mm in length.




Figs 35–38: 35, *Melissotarsus emeryi* ☿, profile view; 36, *Leptothorax angulatus* ☿, profile view; 37, *Cardiocondyla schuckardi* ☿, dorsal view; 38, *Crematogaster auberti* ☿, profile view. (Scale bar 1 mm).

## Genus ***Triglyphothrix*** Forel

This is a genus of shade loving leaf litter ants. In most species the body hairs are long and abundant and usually branched, giving the insect a furry appearance.

**_Triglyphothrix lanuginosa_** (Mayr, 1870) (fig. 50)

*Tetramorium lanuginosum* Mayr, 1870; Verh. zool.-bot. Ges. Wien 20: 972.

*Triglyphothrix lanuginosa* (Mayr) Emery, 1891; Exploration Scientifique Tunisie, Formicid.: 4.

Al Qatif 14.IV.83; ☿☿ CAC.

Two workers were collected in a date palm grove in deep leaf litter. This is a tramp species widely distributed over the tropics but probably originating in tropical Asia. This species has been commonly known as *Triglyphothrix striatidens* but BOLTON (1979) has shown that the original and correct name for this species is *T. lanuginosa.*

## Genus ***Crematogaster*** Lund

| List of species: | Geographical distribution: |
|---|---|
| *Crematogaster acaciae* Forel, 1892 | North east Africa |
| *Crematogaster aegyptiacus* Mayr, 1862 | North east Africa, North Africa |

| | |
|---|---|
| *Crematogaster affabilis* Forel, 1908 | North east Africa |
| *Crematogaster antaris* Forel, 1894 | North Africa |
| *Crematogaster auberti* Emery, 1869 | North Africa, South Europe |
| *Crematogaster chiarinii* Emery, 1881 | North east Africa |
| *Crematogaster laestrygon* Emery, 1869 | North Africa |
| *Crematogaster luctans* Forel, 1907 | Tropical Africa |
| *Crematogaster mimosae* Santschi, 1914 | East Africa |
| *Crematogaster oasium* Santschi, 1911 | North Africa |
| *Cremartogaster senegalensis* Roger, 1862 | Tropical Africa |
| *Crematogaster striaticeps* Forel, 1902 | North Africa |
| *Crematogaster* sp. | Oman |

*Crematogaster* includes species that are both arboreal and ground nesting but colonies are never far from trees or shrubs since members of this genus rely on the exudates of Homoptera as the main source of nourishment. Characteristically, those species with large populous colonies are to be seen moving in slow orderly files to and from sources of food. Many are aromatic and most species in alarm raise the gaster with the apex pointing forward over the body. Males and queens of some species frequently come to light and as in the worker may be easily recognised by the attachment of the pedicel to the dorsum of the first gaster tergite.

## Keys to species

| | | |
|---|---|---|
| 1. | Postpetiole globular, entire not bilobed (colour yellow, spines long) ***luctans*** Forel | |
| – | Postpetiole divided dorsally by a median longitudinal furrow into two lobes ........ | 2 |
| 2.(1) | Head distinctly wider than long, CI more than 115 ........ | 3 |
| – | Head only slightly or not wider than long, CI less than 110 ........ | 8 |
| 3.(2) | Petiole distinctly wider than long ........ | 4 |
| – | Petiole only slightly or not wider than long ........ | 5 |
| 4.(3) | Propodeal spines sharp, at least 0.2 mm; gaster brilliant with fine sparse pubescense, head and alitrunk red ***senegalensis*** Roger | |
| – | Propodeal spines broadly dentate, less than 0.13 mm; gaster with superficial sculpture and coarse pubescense; body colour reddish brown ***aegyptiacus*** Mayr | |
| 5.(3) | Alitrunk paler than head or gaster; spine length 0.2 mm or more ***chiarinii*** Emery | |
| – | Head and alitrunk unicolorous red; spine length 0.15 mm or less ........ | 6 |
| 6.(5) | Head and alitrunk strongly sculptured, spines short and broadly dentate ***mimosae*** Santschi | |
| – | Body sculpture weak; spines reduced to two tubercules ........ | 7 |
| 7.(6) | Occiput shining; second funiculus segment about as long as third ***antaris*** Forel | |
| – | Occiput dull; second funiculus segment shorter than third ***acaciae*** Forel | |
| 8.(2) | Propodeal spines long and thin at least 0.25 mm ........ | 9 |
| – | Propodeal spines less than 0.20 mm ........ | 10 |
| 9.(8) | Head and alitrunk clear red, spines exceptionally long, 0.35 mm or more, spine length/ HW × 100 37 ***Crematogaster*** sp. | |
| – | Body unicolorous dark brown to black; spines 0.25 mm. index 25 ***affabilis*** Forel | |
| 10.(8) | Alitrunk sculpture strong; mesonotal keel well developed ........ | 11 |
| – | Alitrunk sculpture weak; mesonotal keel hardly apparent ........ | 12 |

| | | |
|---|---|---|
| 11.(10) | Head smooth with scattered small punctures | ***laestrygon*** Emery |
| – | Dorsum of head completely striate | ***striaticeps*** Forel |
| 12.(10) | Colour brown to dark brown; spines relatively long, about 0.175 mm | ***auberti*** Emery |
| – | Colour pale red; spines very reduced, 0.1 mm | ***oasium*** Santschi |

***Crematogaster acaciae*** Forel, 1892

*Crematogaster acaciae* Forel, 1892; Zool. Anz. *15:* 142.

Oman: Mugshin, Dhofar 20.IX.79; ☿☿ R.P. Whitcombe.

This is a pale weakly sculptured species with very reduced spines, broad head, CI 108, and a narrow petiole, 03 × 03. The species was described from Ethiopia.

***Crematogaster affabilis*** Forel, 1908 n. stat. (figs 40, 43)

*Crematogaster chiarinii* var. *affabilis* Forel, 1908; Revue Ent. (1908): 142.

Abha flood valley 25.III.83; Najran 25.III.83; Abu Arish 25.III.83; Fayfa 27.III.83; 31.III.83; Al Qahman mangrove swamp 1.IV.83; Karm Rauisch near Al Kudeis 5.IV.83; ♂♂ ☿☿ ♀♀ CAC. Wadi Dhiyan 14.IX.83; ☿☿ W. Büttiker. Yemen: Wadi Magsala XI.79; ☿☿ Borri & Poggesi (B. Lanza). Oman: Sadh Dhofar 17.III.84; Wadi Satima 15.II.84; Salala mangroves 16.II.84; ☿☿ M. Gallagher.

This is a very distinctive species unicolorous black to brownish black, with smooth sculpture and very long propodeal spines, 0.26–0.31 mm. The Arabian specimens matched named examples of *C. affabilis* in both the Forel collection and in NHMB. No other dark coloured African species was seen with such long thin spines. The head is comparatively narrow, CI 104, the petiole scarcely wider than long and there is no mesonotal keel. *C. chiarinii* by contrast has shorter spines, 0.20–0.23, a broader head, CI 115–118, a mesonotal keel, has the head more sculptured and the alitrunk paler than the head and gaster.

Populous colonies were seen within or at the foot of the larger trees and there were long files of ants along the trunks and branches in the manner of *C. scutellaris* 01. of Europe. Myrmecophilous myrmedoniine beetles were seen among workers around the tree bases in a few places.

***Crematogaster aegyptiacus*** Mayr, 1862 (figs 39, 42)

*Crematogaster aegyptiacus* Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 765.

Musimah Dahn 2.IX.81; ☿ W. Büttiker. Fayfa 29.III.83; Al Qahman mangrove swamp 1.IV.83; Karm Rauisch 5.IV.83; Al Qatif 15.IV.83; ☿☿ CAC.

This is a mainly arboreal species but does not form such dense or conspicuous colonies as *C. affabilis*. There is an old record for *C. aegyptiacus* from Aden (Emery 1881).

***Crematogaster antaris*** Forel, 1894

*Crematogaster antaris* Forel, 1894; Bull. Soc. vaud. Sci. nat. *30:* 26.

Al Kharfa desert 24.III.83; ☿☿ CAC.

This is a species with a large head differing from *C. aegyptiacus* by the smooth and shining occiput and narrower petiole. It was taken among scrubby bushes fringing sandy desert and was the only species to be found so far in the Central Region of Saudi Arabia.

***Crematogaster auberti*** Emery, 1869 (fig. 38)

*Crematogaster auberti* Emery, 1869; Annali Accad. Aspir. nat. Napoli *2:* 23.

Al Kola 10.IV.83; ☿☿ CAC.

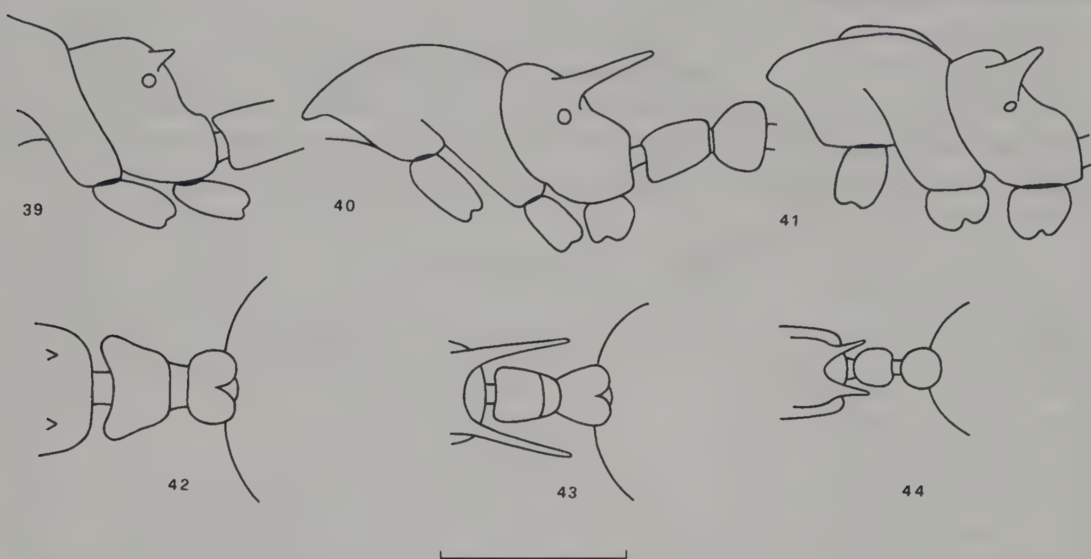
This common South European and North African species was only found at this site in the neighbourhood of a village in semi-cultivated farmland.

***Crematogaster chiarinii*** Emery, 1881

*Crematogaster chiarinii* Emery, 1881; Annali Mus. civ. Stor. nat. Giacomo Doria *16:* 271.

Bishah 7.IV.83; Al Tawlah 7.IV.83; ☿☿ CAC.

This species has the alitrunk somewhat paler than the head and gaster. It was linked by FOREL (1908) with *C. affabilis* but apart from the colour difference, the propodeal spines are shorter, the head wider and the sculpture stronger. An East African species, it was recorded from Tes by EMERY (1881).




Figs 39–41: Part profile of *Crematogaster.* 39, *C. aegyptiacus* ☿; 40, *C. affabilis* ☿; 41, *C. senegalensis* ☿. Figs 42–44: Petiole nodes in dorsal view. 42, *C. aegyptiacus* ☿; 43, *C. affabilis* ☿; 44, *C. luctans* ☿. (Scale bar 1 mm).

***Crematogaster luctans*** Forel, 1907 (fig. 44)

*Crematogaster luctans* Forel, 1907; Annls. hist.-nat. Mus. natn. hung. *5:* 22.

Abu Arish 26.III.83; Fayfa tamarisk grove 29.III.83; Sug al Ahad 26.III.83; ☿☿ ♀ CAC.

This species lives within the hollow twigs of dead acacia branches and was so found by my colleague C. Holzschuh when searching for longhorn beetles. It is the only species with a rounded unindented postpetiole so far found in Arabia. It is characterised by the yellow colour and well developed propodeal spines.

***Crematogaster mimosae*** Santschi, 1914

*Crematogaster mimosae* Santschi, 1914; Voy. Allaud & Jeannel Afr. Or. Hym.: 14.

Oman: Jabal Akhdar 9.VIII.78; ☿☿ R.P. Whitcombe.

This is a strongly sculptured red species recorded from East Africa.

***Crematogaster oasium*** Santschi, 1911 n. stat.

*Crematogaster auberti* ssp. *oasium* Santschi, 1911; Bull. Soc. Hist. nat. Afr. N. *3:* 81.

Oman: Khabura 1.XII.79; ☿ R.P. Whitcombe.

This pale rather shining species with very short spines occurs on the fringes of the North African deserts. It differs from *C. auberti* Emery by the much shorter propodeal spines and paler colour.

***Crematogaster laestrygon*** Emery, 1869

*Crematogaster laestrygon* Emery, 1869; Bull. Soc. ent. ital. *1:* 135.

Zahran 25.III.83; Wadi Shugub 7.IV.83; Anamas 8.IV.83; Tanuma 8.IV.83; Al Qatif 14.IV.83; ☿☿ CAC. Abha 4.XII.83; ☿☿ A.S. Talhouk. Wadi Azizah 2400 m 10.IX.83; ☿☿ W. Büttiker.

This is a common ground nesting North African species. A few workers taken at Al Qahman, 1.IV.83, have the head completely striated but are otherwise similar to the smooth headed *C. laestrygon.* This probably corresponds to *C. laestrygon* var. *striaticeps* Forel, 1902, described from North Africa but whether this is a minor variation or a good species is not yet resolved.

***Crematogaster senegalensis*** Roger, 1862 (fig. 41)

*Crematogaster senegalensis* Roger, 1862; Berl. ent. Z. *7:* 206.

Sug al Ahad 26.III.83; ☿☿ CAC. Sahl Rakbar 3.VI.82; ☿ W. Büttiker.

Workers at Sug al Ahad were taken among tree roots in the immediate vicinity of a clump of trees. This is a brightly coloured species with comparatively long funiculus segments and broad strong spines. It is recorded from several localities in East Africa.

## Genus ***Tetramorium*** Mayr

| List of species: | Geographical distribution: |
|---|---|
| *Tetramorium biskrense* Forel, 1904 | North Africa, Sicily |
| *Tetramorium caldarium* (Roger, 1857) | Cosmopolitan |
| *Tetramorium calidum* Forel, 1907 | South Arabia |
| *Tetramorium depressiceps* Menozzi, 1933 | North east Africa, Middle East |
| *Tetramorium doriae* Emery, 1881 | North east Africa, South Arabia |
| *Tetramorium ferox* Ruzsky, 1903 | North Africa, South east Europe |
| *Tetramorium jizani* n. sp. | Arabia |
| *Tetramorium juba* n. sp. | North & North east Africa |
| *Tetramorium khyarum* Bolton, 1980 | Tropical Africa |
| *Tetramorium sericeiventre* Emery, 1877 | Throughout Africa |
| *Tetramorium simillimum* (Smith, 1851) | Cosmopolitan |
| *Tetramorium syriacum* Emery, 1909 | Middle East |
| *Tetramorium zabrae* Santschi, 1923 | North Africa, South Arabia |

### Key to species

| | | |
|---|---|---|
| 1. | Tibiae without suberect hairs on extensor surface . . . . . . . . . . . . . . . . . . . . . . . . . . . | 2 |
| – | Tibiae with stout suberect hairs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 7 |
| 2.(1) | Larger species, HW 0.70 mm or more; petiole nodes longer than broad . . . . . . . . . . . | 3 |
| – | Smaller species, HW 0.56 mm or less; petiole nodes broader than long . . . . . . . . . . . . | 5 |
| 3.(2) | Propodeal spines minute or absent | ***doriae*** Emery |
| – | Propodeal spines strongly developed . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 4 |
| 4.(3) | Propodeal dorsum with one or two pairs of stout hairs | ***khyarum*** Bolton |
| – | Propodeal dorsum bare | ***sericeiventre*** Emery |
| 5.(2) | Longitudinal rugae on head weakly developed | ***caldarium*** Roger |
| – | Longitudinal rugae on head strongly developed . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 6 |

6.(5) Frontal carinae long and strongly developed to near occipital border, genae between occiput and eye without projecting setae ***simillimum*** (Smith)
– Frontal carinae obscured by close head sculpture, genae between occiput and eye with one or more projecting hairs ***jizani*** n. sp.
7.(1) Petiole nodes with distinct dorsal sculpture ........ 8
– Petiole nodes without dorsal sculpture, smooth and shining ........ 9
8.(7) Nodes coarsely sulcate; petiole width more than 0.8 × postpetiole width; colour dark blackish brown ***ferox*** Ruzsky
– Nodes weakly or irregularly sculptured ; petiole width × 0.75 postpetiole width; colour reddish to pale brown ***syriacum*** Emery
9.(7) Head and alitrunk sculpture strongly developed ........ 10
– Head and alitrunk sculpture weak and smooth in part ........ 11
10.(9) Colour black; spines very short upturned; striae distinctly divergent on occiput ***biskrense*** Forel
– Colour pale reddish yellow; spines acute and well developed; head striae remain longitudinal to occipital border ***calidum*** Forel
11.(9) Dorsum of head with distinct depressed area medially; alitrunk sculpture weak but always present; spines short but acute ***depressiceps*** Menozzi
– Dorsum of head without a median depression; alitrunk smooth and shining; propodeal armature bluntly tuberculate ***juba*** n. sp.

***Tetramorium biskrense*** Forel, 1904

*Tetramorium caespitum* var. *biskrensis* Forel, 1904; Revue suisse Zool. *12:* 13.
*Tetramorium biskrensis.* – Bernard, 1958; Riv. Biol. colon. *16:* 75.
*Tetramorium biskrense.* – Baroni Urbani, 1971: 134.

Hair valley 17.IV.83; ☿☿ CAC.

This is a small dark sculptured species of the *T. caespitum* group with relatively small sexuals. The postpetiole has some sculpture at the sides but both petiole and postpetiole are brilliant and smooth on the centre dorsum.

***Tetramorium caldarium*** (Roger, 1857)

*Tetrogmus caldarium* Roger, 1857; Berl. ent. Z. *1:* 12.
*Tetramorium caldarium.* – Roger, 1862; Berl. ent. Z. *6:* 297.

Abu Arish 26.III.83; Fayfa 29.III.83; 30.III.83; Al Qatif 15.IV.83; Riyadh Agricultural Centre 18.IV.83; ☿☿ CAC.

This is a common widely distributed tramp species. Specimens were taken in soil and leaf litter.

***Tetramorium calidum*** Forel, 1907 n. stat.

*Tetramorium caespitum* var. *calida* Forel, 1907; Annls hist.-nat. Mus. natn. hung. *5:* 15.

No examples referable to this form were collected. A paratype in NHMB was examined. This worker has rounded unsculptured nodes and rather widely spaced rugae on the head and alitrunk. The occiput is slightly concave. The scape almost reaches the occipital border. The propodeal spines are short sharp and suberect. The colour is pale yellowish red. The type locality is Muscat in Oman. It is given specific rank here because of its location so far south, its colour and small details of sculpture.

***Tetramorium depressiceps*** Menozzi, 1933

*Tetramorium semilaeve* ssp. *depressiceps* Menozzi, 1933; Memorie Soc. ent. ital. *12:* 71.
*Tetramorium depressiceps.* – Tohmé, 1969: 12.

Wadi Shugub 7.IV.83; Shaqiq-Shamran 8.IV.83; Anamas 8.IV.83; ☿☿ CAC.

This species was common in the upland pastures of the Asir mountains. The colour is somewhat paler than in the type specimens but the head depression is very clear. It has been recorded from several Middle East countries including Lebanon, Palestine and the type locality, Sinai.

***Tetramorium doriae*** Emery, 1881

*Tetramorium doriae* Emery, 1881; Annali Mus. civ. Stor. nat. Giacomo Doria *16:* 530.

This species was not collected but the type was described from Tes in Southern Arabia and it has also been recorded from localities in North-east Africa (Bolton 1980).

***Tetramorium ferox*** Ruzsky, 1903

*Tetramorium caespitum* var. *ferox* Ruzsky, 1903; Trudy russk. ent. Obshch. *36:* 309.
*Tetramorium ferox.* – Cori & Finzi, 1931; Sber. Akad. Wiss. Wien, math.-naturw. Kl. *23:* 3.

Kashm al Buwaybiyat V. 78; ☿☿ W. Büttiker. Riyadh Agricultural Centre 23.III.83; ☿☿ CAC.

These have the dark colour, coarse sculpture and large petiole of *T. ferox* but the propodeal spines are distinctly shorter than in examples from both South Russia and Morocco and resemble in this respect series collected in Greece.

***Tetramorium jizani*** n. sp. (fig. 48)

Fayfa 30.III.83; Al Qahman mangrove swamp 1.IV.83; Abu Arish 3.IV.83; ☿☿ ♀♀ CAC.

A few specimens collected from soil litter could not be identified to species from the keys by Bolton 1980, to the subsaharan African *Tetramorium.* In general appearance and size they resemble *T. simillimum* (Smith) but the head of the worker is more closely sculptured, the frontal grooves narrower and there are genal hairs between the occiput and eye and the eye and the mandible.

Holotype worker: Abu Arish 9.IV.83: TL 2.3; HL 0.65; HW 0.55 SL 0.46; EL 0.14; Petiole Width 0.18; Postpetiole Width 0.23; CI 84.6; SI 83.

The mandibles are striated; the head and alitrunk dorsally are closely and finely longitudinally striated. The frontal ridges extend to posterior eye level and are then obscured by the general sculpture. The colour is reddish brown. The tibiae and scapes have close decumbent pubescent hairs. Suberect hairs on the head and alitrunk are numerous with one or more projecting at the sides of the head between the occipital corner and eye and two hairs projecting between eye and the mandible insertions.

Paratype queens have similar sculpture to the workers but projecting hairs on the head are longer and more numerous. HL 0.85; HW 0.83; SL 0.69; CI 98; SI 83.3.

Holotype and paratypes in NHMB

***Tetramorium juba*** n. sp. (fig. 47)

*Tetramorium caespitum* st. *juda* (sic) var. *juba* Santschi, 1921; Mems R. Soc. esp. Hist. nat. Tome 50 Aniv.: 433.

Al Kharj 16.IV.78; ♀♀ W. Büttiker. Al Kharj sandy desert 23.III.83; Al Kola 10.IV.83; ☿☿ ♀♀ CAC.

Santschi (1921) described *T. juba* as a variety of *T. judas* Wheeler *(Tetramorium caespitum* ssp. *judas* Wheeler, 1906, Bull. Mus. comp. Zool. Harv. 60: 172). However *T. judas* Wheeler from Palestine is somewhat smaller, darker and more sculptured. According to Menozzi 1933, in *T. judas* (*Tetramorium semilaeve* ssp. *judas* Wheeler), the queens have the petiole nodes striate and opaque and the head and alitrunk are more sculptured than those of *T. semilaeve* André. In worker associated *T. juba* queens, only

the head has some striate sculpture and the dorsum of the mesonotum, scutellum, centre of the propodeum and petiole are smooth without sculpture.

The descriptions of a typical worker and a queen of *T. juba* from Al Kharj are as follows:

Worker: TL 3.38; HL 0.83; HW 0.69; SL 0.68; CI 83.3; SI 98; Head has mildly concave occiput, sides almost straight, distinctly striate on the dorsum anterior to the eyes, more finely posteriorly to occiput where the striae diverge. Promesonotum with fine scattered punctures but smooth and shining, propodeum finely cross striate; nodes dorsally smooth and shining. Sides of alitrunk striate. Postpetiole wide, × 1.36 petiole width. Propodeal armature reduced to short blunt tubercules. Colour evenly yellowish brown.

Queen: TL 7.0; HL 1.23; HW 1.15; SL 0.98; CI 96; SI 83; Postpetiole x 1.5 width of petiole. Head striate distinctly divergent at occiput. Dorsum of mesonotum and scutellum smooth and shining without trace of striae. Middle of propodeum and petiole smooth; postpetiole finely striate. Colour as worker.

***Tetramorium khyarum*** Bolton, 1980 (fig. 46)

*Tetramorium khyarum* Bolton, 1980; Bull. Br. Mus. nat. Hist. *40* (3): 327.

Abu Arish resthouse grounds 25.III.83; Bishah 8.IV.83; ☿☿, CAC.

These are identical with the common and widespread African savannah species *T. sericeiventre* Emery but all workers have one and occasionally two pairs of hairs on the propodeal dorsum which is always bare in *T. sericeiventre.*

***Tetramorium sericeiventre*** Emery, 1877 (fig. 49)

*Tetramorium sericeiventre* Emery, 1877; Annali Mus. civ. Stor. nat. Giacomo Doria *9:* 370.

Al Khubra 29.V.78; Al Kharj 25.V.80; Wadi Azizah 18.IX.83; ♂♂ ☿☿ W. Büttiker. Riyadh 22.III.83; Al Kharj 23.III.83; Al Tawlah 8.IV.83; Anamas 8.IV.83; Al Qatif 14.IV.83; ♂♂ ☿☿ ♀♀ CAC.

This was the most abundant *Tetramorium* species seen. It has not been recorded from the Middle East but occurs sporadically in North Africa becoming increasingly common to the south throughout the savannah areas of tropical Africa. Males of this species often come to light and may be recognised by the ten segmented antenna, the long second segment being a characteristic shared by all members of the genus, the long petiole nodes, distinct propodeal teeth and the very deep metanotal furrow.

***Tetramorium simillimum*** (Smith, 1851)

*Myrmica simillima* Smith, 1851; List Brit. Anim. Brit. *Mus. 6,* Aculeata: 118.

*Tetramorium simillimum* (Smith) Mayr, 1861: 15.

Riyadh 22.III.83; Abu Arish 26.III.83; Fayfa 30.III.83; 31.III.83; Al Kudeis 5.IV.83; Al Qatif 14.IV.83; ☿☿ CAC.

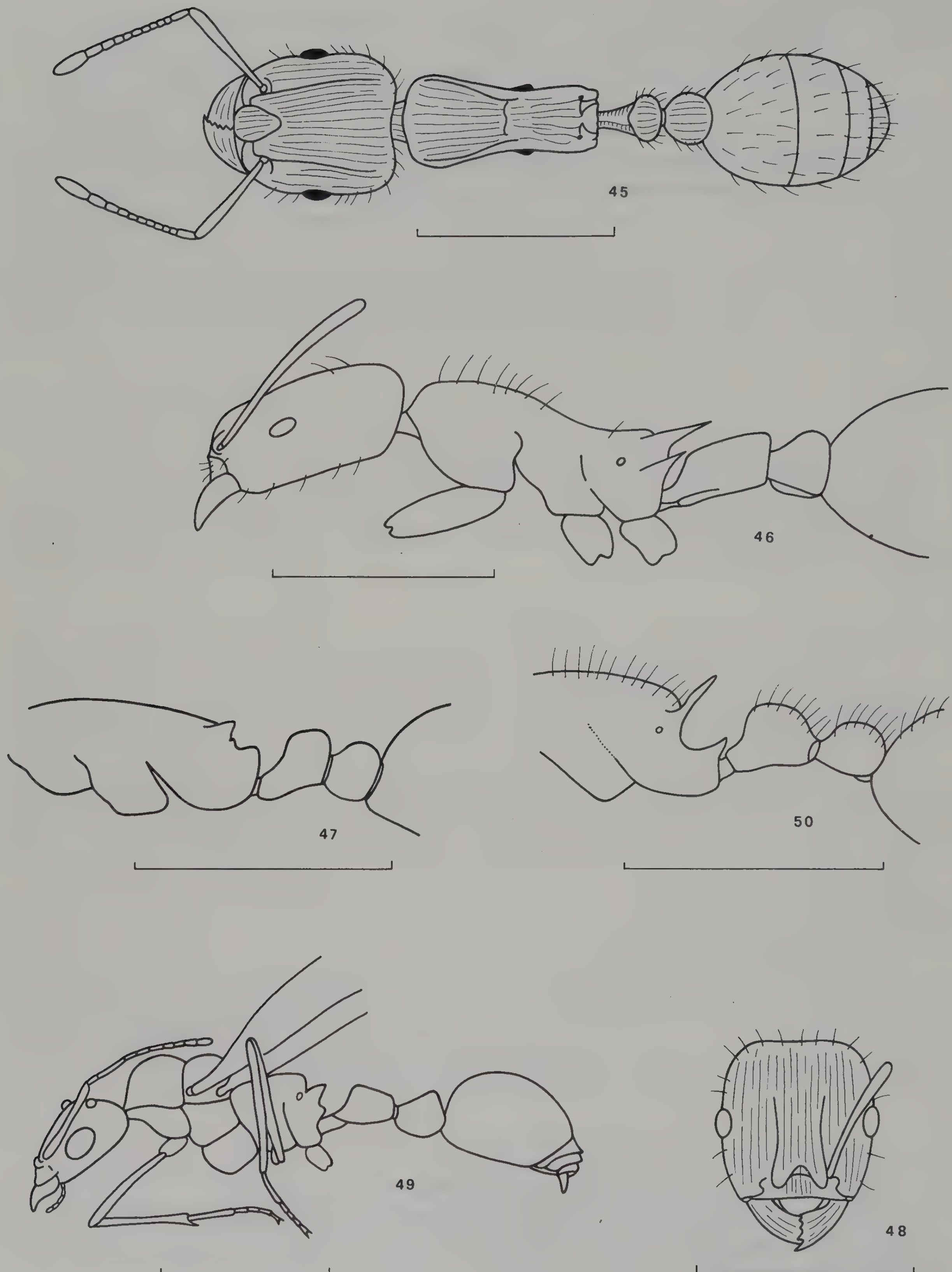
This is a common small species widely distributed through commerce over the whole subtropical and tropical world and found also in heated glasshouses in cooler climates.

***Tetramorium syriacum*** Emery, 1909 n. stat. (fig. 45)

*Tetramorium caespitum* var. *syriaca* Emery, 1909; Dt. ent. Z. (1909): 699.

Wadi Hanifa 7.V.76; Wadi Darmah 22.XII.76; Kushm al Buwaybiyat 25.V.78; Al Khubra 29.V.78; ♂♂ ☿☿ ♀♀ W. Büttiker. Riyadh Agricultural Centre 23.III.83; 19.IV.83 ♂♂ ☿☿ ♀♀ CAC. Riyadh 19.IV.83; ♂♂ ♀♀ R.A. Abozuhairah.

This reddish species with sculptured nodes is evidently locally common in the Central Region but not seen elsewhere. The queens have short longitudinal striae at the anterior of the first gaster tergite




Figs 45–50: 45, *Tetramorium syriacum* ☿, dorsal view; 46, *T. khyarum* ☿, profile view; 47, *T. juba* ☿, part profile; 48, *T. jizani* ☿, head in dorsal view; 49, *T. sericeiventre* ♂, profile view; 50, *Triglyphothrix lanuginosa* ☿, part profile.. (Scale bar 1 mm).

while the scutellum has the median area smooth. These characters are in accord with samples from the Middle East but all workers from Arabia have the propodeal spines shorter than in the typical form and in this respect resemble specimens labelled var. *punctaticeps* Santschi in the NHMB from Tunisia.

***Tetramorium zahrae*** Santschi, 1923

*Tetramorium zahrae* Santschi, 1923; Boln. R. Soc. esp. Hist. nat. *23:* 135.

There is a small pale male and a dark queen without workers in the NHMB labelled *T. zahrae* Santschi from Yemen: Sokra leg. G. Scortelli. They appear to resemble *T. biskrense* in size and sculpture. In the absence of workers, this species is not included in the key to species.

## Genus *Monomorium* Mayr

| List of species: | Geographical distribution: |
|---|---|
| *Monomorium abeillei* André, 1881 | Middle East |
| *Monomorium afrum* André, 1884 | East and South Africa |
| *Monomorium areniphilum* Santschi, 1911 | North Africa |
| *Monomorium barbatulum* Mayr, 1877 | Turkestan |
| *Monomorium bicolor* Emery, 1877 | North Africa, Middle East |
| *Monomorium carbonarium* (Smith, 1858) | Madeira, Azores; Arabia ? |
| *Monomorium clavicorne* André, 1881 | Africa, Middle East |
| *Monomorium destructor* (Jerdon, 1851) | Cosmopolitan |
| *Monomorium gracillimum* (Smith, 1861) | Cosmopolitan |
| *Monomorium karawajewi* Forel 1913 | Middle East |
| *Monomorium luteum* Emery, 1881 | South Arabia |
| *Monomorium nitidiventre* Emery, 1883 | Africa, Middle East, South Arabia |
| *Monomorium niloticum* Emery, 1881 | North east Africa |
| *Monomorium pharaonis* (Linnaeus, 1758) | Cosmopolitan |
| *Monomorium phoenicium* Santschi, 1927 | North Africa, Middle East |
| *Monomorium salomonis* (Linnaeus, 1758) | North Africa |
| *Monomorium schultzei* Forel, 1910 | South Africa |
| *Monomorium subopacum* (Smith, 1858) | South Europe, North Africa |
| *Monomorium venustum* (Smith, 1858) | Middle East, Arabia |
| *Monomorium zulu* Santschi, 1914 | South Africa |

This is a large genus of small to minute species, some of which are cosmopolitan in their distribution and are often household pests. All sites visited in 1983 had one or more species of *Monomorium* present and members of the genus were often abundant in coastal areas, cultivated farm land and in the neighbourhood of dwellings.

### Key to species

1. Ultimate funiculus segment as long as the two preceding together, the first of the three segments forming the club being shorter than the second ........................ 2

– Ultimate funiculus segment shorter than the length of the preceding two together which are subequal ........................ 6

2.(1) Antennae eleven segmented **clavicorne** André
– Antennae twelve segmented . . . . . . . . . . 3
3.(2) Head and alitrunk with close punctulate microsculpture, dull not shining **pharaonis** (L.)
– Head and alitrunk at least moderately shining . . . . . . . . . . 4
4.(3) Colour uniformly blackish brown **carbonarium** (Smith)
– Colour yellowish grey or yellow . . . . . . . . . . 5
5.(4) Head and alitrunk smooth and shining, yellow **zulu** Santschi
– Head and alitrunk with diffuse punctulate sculpture; colour greyish yellow, rather dull **schultzei** Forel
6.(1) Antennal scape short, clearly not reaching occiput . . . . . . . . . . 7
– Antennal scape reaching or surpassing occiput . . . . . . . . . . 10
7.(6) Eyes large EL: HL 0.3; gula hairs long and curved forming a psammophore **barbatulum** Mayr
– Eyes small EL; HL 0.15; gula with short hairs only . . . . . . . . . . 8
8.(7) Body colour evenly brownish to brownish black **karawajewi** Forel
– At least apex of gaster darker than rest of body . . . . . . . . . . 9
9.(8) Head and alitrunk pale reddish brown or testaceous **gracillimum** (Smith)
– Head and alitrunk clear yellow **destructor** (Jerdon)
10.(6) Metanotal furrow a deep broad trench, in profile forming a right angle between mesonotum and propodeum . . . . . . . . . . 11
– Metanotal furrow shallow, in profile forming an oblique angle . . . . . . . . . . 13
11.(10) Head coarsely sculptured, darker than reddish mid body; propodeal dorsum convex without a median concave area **areniphilum** Santschi
– Head finely sculptured, unicolorous clear red with alitrunk; propodeum with median longitudinal flattened or incavate area . . . . . . . . . . 12
12.(11) Penultimate funiculus segment more than twice as long as broad; head relatively long widening anteriorly, CI 75–81 **niloticum** Emery
– Penultimate funiculus segment less than twice as long as broad; head shorter more rectangular, CI 83–86 **venustum** (Smith)
13.(10) Propodeum with a distinct longitudinal median furrow . . . . . . . . . . 14
– Propodeum without a distinct median furrow, at most slightly incavate posteriorly . . . 15
14.(13) Head and alitrunk dull red, contrasting with dark gaster **phoenicium** Santschi
– Head and alitrunk shining brownish black, uniform with dark gaster **abeillei** André
15.(13) Head, alitrunk and most of gaster yellowish, head, alitrunk and antennae exceptionally long **luteum** Emery
– Colour otherwise; body and appendages not exceptionally long . . . . . . . . . . 16
16.(15) Head and alitrunk clear red contrasting with dense black gaster . . . . . . . . . . 17
– Head and alitrunk reddish brown or dark not well contrasted with gaster . . . . . . . . . . 18
17.(16) Head and antennal scapes relatively short, whole dorsum with scattered long hairs **nitidiventre** Emery
– Head rectangular, scapes clearly surpass occipital margin; alitrunk dorsum without hairs **bicolor** Emery
18.(16) Head densely sculputured and dull . . . . . . . . . . 19
– Head moderately shining with only superficial sculpture **salomonis** (L.)
19.(18) Whole body uniformly dark; metanotal furrow deep and distinct **afrum** André
– Alitrunk and often head lighter than gaster; metanotal furrow shallow scarcely breaking dorsal outline of alitrunk in profile **subopacum** (Smith)

***Monomorium abeillei*** André, 1881 (figs 52, 60)

*Monomorium abeillei* André, 1881; Annls. Soc. ent. Fr.(6) *1:* 67.

Riyadh Agricultural Centre 7.III.75; 7.VII.75; ☿☿ W. Büttiker. Zahran 25.III.83; Abu Arish 25.III.83; Karm Rauisch 5.IV.83; Al Tawlah 7.IV.83; Anamas 8.IV.83; Sawdah Mt. 9.IV.83; desert between Abha and Najran 10.IV.83; Sulaiel desert 11.IV.83; Hofuf sand mountain 13.IV.83; Al Qatif coastal beach 15.IV.83; ☿☿ ♀♀ CAC. Oman: Khabura III.79; ☿ R.P. Whitcombe.

This proved to be one of the commoner *Monomorium* species found equally in sandy desert, coastal areas and on high ground in the Asir mountains. It is a common Middle East species and is easily recognisable from its small size, dark colour and rather shining appearance and by the distinctive longitudinal furrow on the dorsum of the propodeum.

***Monomorium afrum*** André, 1884 (fig. 51)

*Monomorium afrum* André, 1884; in Magretti, Annali Mus. civ. Stor. nat. Giacomo Doria *21:* 540.

Al Kola 10.IV.83; desert between Abha and Najran 10.IV.83; Sulaiel desert 11.IV.83; ☿☿ ♀♀ CAC.

This is rather similar to *M. abeillei* but larger, more sculptured and with a more square head. The posterior dorsum of the propodeum is hollowed but unlike *M. abeillei,* the furrow does not extend as far as the metanotal break. In the queen, the alitrunk is higher and more rounded, the petiole thinner and higher and the head at least as wide as long, CI 100 (*M. abeillei* CI 92). The eyes are distinctly larger, occupying more than 0.35 x HL compared with *M. abeillei* (x 0.27).

According to the Forel collection, the Arabian samples resemble specimens labelled *asmarensis* Forel (*M. afrum* var. *asmarensis* Forel, 1910, Zool. Jb. Abt. Syst. *29:* 250) being brownish black rather than dull black but this is assumed to be a minor colour variation.

***Monomorium areniphilum*** Santschi, 1911 n. stat.

*Monomorium salomonis* var. *areniphila* Santschi, 1911; Bull. Soc. Hist. nat. Afr. N. *3:* 84.

*Monomorium (Xeromyrmex) salomonis* st. *areniphilum.* – Santschi, 1936; Bull. Soc. Sci. nat. Maroc *16:* 57.

Nuwayriyah 20.IV.80; ☿☿ W. Büttiker.

This is like a large *M. salomonis* (L.) but is more shining with a much deeper metanotal furrow and more rounded propodeum which clearly differentiate it as a separate species and not a subspecies of *M. salomonis.*

***Monomorium barbatulum*** Mayr, 1877

*Monomorium barbatulum* Mayr, 1877; in Fedschenko, Voy. Turkestan, Formicid.: 17.

Oman: Wahiba sands 7.XII.84; ☿☿ W. Gallagher.

This is a central Asian species which has also been recorded from Afghanistan (Collingwood 1960) but not so far, from the Middle East or Arabia. It is a small, dark, large headed species superficially resembling a large worker of *M. karawajewi* but immediately distinct by its large eyes and long curved gula hairs.

***Monomorium bicolor*** Emery, 1877 (fig. 54)

*Monomorium bicolor* Emery, 1877; Annali Mus. civ. Stor. nat. Giacomo Doria *9:* 368.

Abu Arish 26.III.83; Karm Rauisch 5.IV.83; Al Qatif coast 14.IV.83; Riyadh Agricultural Centre 19.IV.83; ☿☿ ♀ CAC.

This small sculptured but brightly coloured species is well known from various localities in North Africa and the Middle East.

**_Monomorium clavicorne_** André, 1881

*Monomorium clavicorne* André, 1881; Annls. Soc. ent. Fr. (6) *1:* 68.

Riyadh Agricultural Centre 22.III.83; 19.IV.83; Fayfa 27.III.83; Al Qatif 15.IV.83; Hair valley 17.IV.83; ☿☿ CAC.

Workers of this minute yellow species were found only as single foragers in soil and litter. *M. clavicorne* is recorded from tropical Africa as well as the Middle East.

**_Monomorium carbonarium_** (Smith, 1858)

*Myrmica carbonaria* Smith, 1858; Cat. Hym. Brit. Mus. *6:* 127.

*Monomorium carbonarium* (Smith) Roger, 1863; Berl. ent. Z. *7:* 31.

This was recorded by Forel (1907) from Muscat leg. Biro but no recent examples have been seen. This species was described from Madeira and occurs abundantly on the islands of the Azores but is not so far known from Africa. Two small dark workers from Oman in collections sent by Mr. M. Gallagher are about the same size as *M. carbonarium* but resemble in their antennal conformation small workers of *M. hesperium* Emery.

**_Monomorium destructor_** (Jerdon, 1851)

*Atta destructor* Jerdon, 1851; Madras J. Lit. & Sci. *17:* 105.

*Monomorium destructor* (Jerdon) Emery, 1893; in Dalla Torre, Cat. Hym. *7:* 66.

Makkah 8.XII.79; ☿☿ W. Büttiker. Sug al Ahad riverside 26.III.83; Al Qahman mangrove swamp 1.IV.83; ☿☿ CAC.

This is a wide ranging cosmopolitan species and a well known pest in the Americas. It is a light yellow species with only the apical segments of the gaster dark but is otherwise similar to the slightly darker *M. gracillimum.* The Sug al Ahad specimens were taken from a colony in a partly rotten tree.

**_Monomorium gracillimum_** (Smith, 1861) (fig. 57)

*Myrmica gracillima* Smith, 1861; J. Proc. Linn. Soc. London *6:* 34.

*Monomorium gracillimum* (Smith) Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 753.

Riyadh 26.IV.75; 10.III.80; Jeddah 26.V.75; 26.V.79; Makkah 35 km south 8.XII.79; Hofuf 20.VI.78; 23.V.79; Sanam 28.VIII.80; Shoiba 6.XII.83; Wadi Hanaq 20.I.84; ☿☿ ♀♀ W. Büttiker. Riyadh 19.III.83; Abu Arish 25.III.83; Fayfa 30.III.83; Karm Rauisch 5.IV.83; scrub desert west of Najran 10.IV.83; Sulaiel desert 11.IV.83; ☿☿ ♀♀ CAC. Socotra III.76 ☿☿ ♀♀ K.M. Guichard. Oman: Dhofar XI.79; ☿ R.P. Whitcombe.

This is a very common tropicopolitan species, abundant on the Indian subcontinent but found throughout the old world tropics. It is one of the few species previously recorded from Arabia (Muscat, Forel 1907).

**_Monomorium karawajewi_** Forel, 1913 n. stat. (provisional)

*Monomorium gracillimum* var. *karawajewi* Forel, 1913; Revue suisse Zool. *21:* 437.

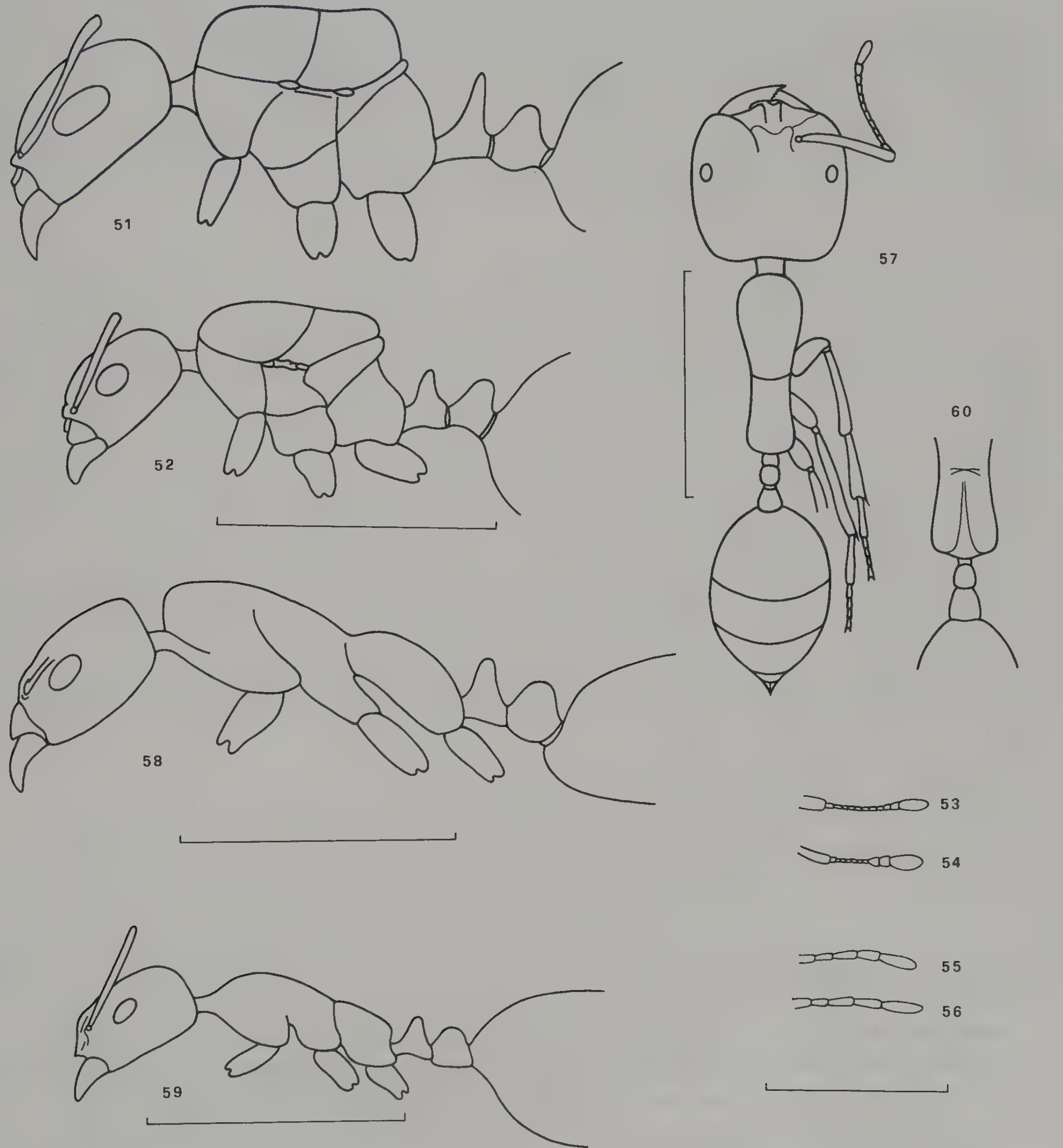
Wadi Khumra 10.II.78; Al Mindak 8.IV.80; An Naahmah 12.X.83; ☿☿ W. Büttiker. Al Tawlah 7.IV.83; Wadi Shugub 7.IV.83; Bishah 7.IV.83; Sulaiel 11.IV.83; Riyadh Agricultural Centre 12.IV.83; Al Qatif 14.IV.83; ♂♂ ☿☿ ♀ CAC.

This varietal name has been applied to a form of *M. gracillimum* that is evenly brownish to black, occurring in the Middle East. It is given provisional species status here because of the apparent consistency of the colour difference but there is no other discernible difference in form, sculpture or pilosity to make a specific distinction beyond doubt.

## *Monomorium luteum* Emery, 1881

*Monomorium luteum* Emery, 1881; Annali Mus. civ. Stor. nat. Giacomo Doria *16:* 532.

This was described from Tes in Southern Arabia. Examples in NHMB and others sent by M. Gallagher from Oman have the body colour yellow except for the brown apex of the gaster. Workers resemble those of *M. niloticum* in the length of the head and appendages but the alitrunk is relatively longer and structurally different in the much more shallow metanotal impression.




Figs 51–60: Genus *Monomorium*. 51, *M. afrum* ♀, profile view; 52, *M. abeillei* ♀, profile view; 53, *M. zulu* ☿, funiculus; 54, *M. clavicorne* ☿, funiculus; 55, *M. venustum* ☿, funiculus club; 56, *M. niloticum* ☿, funiculus club; 57, *M. gracillimum* ☿, dorsal view; 58, *M. venustum* ☿, profile view; 59, *M. phoenicium* ☿, profile view; 60, *M. abeillei* ☿, propodeum in dorsal view. (Scale bar 1 mm).

***Monomorium nitidiventre*** Emery, 1893 n. stat.

*Monomorium bicolor* ssp. *nitidiventris* Emery, 1893; Annls. Soc. ent. Fr. *62:* 256.

Fayfa 29.III.83; Abu Arish 2.IV.83; ☿☿ ♀ CAC.

This small bicoloured species was first described from Aden in South Arabia. It differs from *M. bicolor* in the shorter head and appendages – the scape does not reach the occipital border – and by the presence of more numerous long dorsal hairs distributed over the alitrunk.

***Monomorium niloticum*** Emery, 1881 (fig. 56)

*Monomorium niloticum* Emery, 1881; Annali Mus. civ. Stor. nat. Giacomo Doria *16:* 531.

Araida 9.V.75; Wadi Hismah 29.IX.80; Wadi Hanaq 8.V.83; Ras Hatibah 11.X.83; ☿☿ W. Büttiker. Abu Arish resthouse grounds 3.V.83; Al Qatif date palms 13.IV.83; Riyadh town 19.IV.83; ☿☿ CAC. Oman: Sifar Al Shayk 2.III.83; Marbat Dhofar 18.II.84; ☿☿ M. Gallagher.

This is one of the larger *Monomorium* species similar to *M. venustum* (Smith) but generally of a brighter colour and with both the head and the antennal segments more elongate. It was described from Egypt but also recorded from Arabia as *M. niloticum* var. *grandis* FOREL (1910).

***Monomorium pharaonis*** (Linnaeus, 1758)

*Formica pharaonis* Linnaeus, 1758; Syst. Nat. Ed. 10, *1:* 580.

*Monomorium pharaonis* (L.) Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 752.

This common cosmopolitan small yellow species was not actually seen but according to Mr. Nimah Majid Awami, Public Health Entomologist to ARAMCO, it is a common household pest in the Eastern Region.

***Monomorium phoenicium*** Santschi, 1927 (fig. 59)

*Monomorium salomonis* ssp. *subopacum* var. *phoenicia* Emery, 1908; Dt. ent. Z.: 677.

*Monomorium (Xeromyrmex) subopacum* var. *phoenicium* Santschi, 1927; Bull. et Annls. Soc. ent. Belg. *67:* 242.

*Monomorium phoenicium.* – Tohmé, 1969: 11

Tobuk 24.IV.77; ☿☿ KAU – NHMB Expedition. Addar 7.I.83; ☿☿ W. Büttiker. Sug al Ahad riverside 26.III.83; Fayfa 27.III.83; 28.III.83; Abu Arish 2.IV.83; Anamas 8.IV.83; ☿☿ CAC.

This bicoloured species is like *M. abeillei* immediately recognisable by the distinctive longitudinal furrow on the propodeum. It is common in the Middle East and occurs also in North Africa.

***Monomorium salomonis*** (Linnaeus, 1758)

*Formica salomonis* Linnaeus, 1758; Syst. Nat. Ed. 10, *1:* 580.

*Monomorium salomonis* (L.) Roger, 1862; Berl. ent. Z. *6:* 294.

Hofuf tamarisk park 13.IV.83; ☿☿ CAC. Kuwait 1979; ☿ K. Dumpert.

This is a common North African species.

***Monomorium schultzei*** Forel, 1910

*Monomorium schultzei* Forel, 1910; in Schultze, Zool. Arthrop. Reise Afr. Formicid. 1910: 18.

Wadi Majarish 7.I.83; ☿☿ W. Büttiker.

This is a rather dull yellow sculptured species in the *M. minutum* species group. The first node is distinctly higher than the second, both being about the same width.

***Monomorium subopacum*** (Smith, 1858)

*Myrmica subopaca* Smith, 1858; Cat. Hym. Brit. Mus. *6:* 127.

*Monomorium subopacum* (Smith) Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 753.

Najran 24.III.83; Hofuf Agricultural Centre 13.IV.83; ☿☿.

Typical samples of this dull coloured South European/North African species were collected in grassy litter.

***Monomorium venustum*** (Smith, 1858) (figs 58, 55)

*Myrmica venusta* Smith, 1858; Cat. Hym. Brit. Mus. *6:* 127.

*Monomorium venustum* (Smith) Roger, 1863; Berl. ent. Z. *7:* 32.

Jeddah 26.V.75; Afif 8.IX.75; Araida 9.IX.75; Al Fresh 20.IV.77; Al Khubra 29.VII.78; Wadi Tinan 16.V.79; Jebel an Nir 2.X.79; Wadi Shugub 11.IV.80; Ar Rayn 25.VIII.80; Wadi Ellah 8.IV.83; Wadi Hismah 24.IX.80; Khartan 12.IV.81; Bani Musayqirah 16.IX.81; Wadi Hilah 8.IX.83; Wadi Majarish 9.I.83; Ras Hatibah 11.X.83; Shoiba 24.XI.83; ☿☿ W. Büttiker. Riyadh Agricultural Centre 22.III.83; Wadi Kust 7.IV.83; Al Tawlah 7.IV.83; Al Kola 10.IV.83; Najran 10.IV.83; Al Qatif 14.IV.83; 15.IV.83; Hair 17.IV.83; ☿☿ ♀♀ CAC. Oman: Dhofar XI.79; ☿☿ R.P. Whitcombe. Khabura XI.83; ☿☿ M. Gallacher.

This abundant and conspicuous species is recorded from the Middle East and North East Africa. It appears to be dominant in many types of terrain in Arabia.

***Monomorium zulu*** Santschi, 1914 (fig. 53)

*Monomorium zulu* Santschi, 1914; Göteborgs K. Vetensk. – o. Vitterh Samh. Handl. *15:* 18.

Sanam 1030 m 28.VIII.80; Wadi Azizah 18.IX.83; ☿☿ W. Büttiker. Bishah 7.IV.83; Anamas 8.IV.83; Sawdah mountain 9.IV.83; ☿☿ CAC.

This ant had the size, appearance and habits of an European *Diplorhoptrum* species. It was found nesting in dense clusters under stones in the Asir mountains. There are many such minute yellow *Monomorium* species and it is not certain that this is correctly named. However specimens resemble well enough *M. zulu* from Central South Africa in NHMB and differ in detail from *M. crawleyi* Santschi from Egypt according to a paratype kindly loaned by Mr. Barry Bolton of BMNH which has the head more punctulate, the nodes duller and the tibiae with fewer hairs than *M. zulu.*

## Subfam. **Formicinae**

### Key to genera

1. Antennae 12 segmented .......... 2
– Antennae 11 segmented .......... 5
2.(1) Antennal insertions distant from clypeal margin .......... 3
– Antennal insertions close to or contiguous with clypeal margin .......... 4
3.(2) Petiole with spines or teeth; pronotum anteriorly bidentate **Polyrhachis** Smith
– Petiole entire or emarginate never dentate; pronotum rounded or angled anteriorly without projecting teeth. **Camponotus** Mayr
4.(2) Ocelli present and distinct. Anterior of gula with long curved hairs **Cataglyphis** Foerster
– Ocelli vestigial or absent. Anterior of gula with short hairs only **Paratrechina** Motschulsky
5.(1) Propodeum bituberculate or bidentate; petiole incised and usually bidentate **Acantholepis** Mayr
– Propodeum unarmed; petiole never emarginate .......... 6

6.(5) In dorsal view metanotum visibly separated from mesonotum by a deeply impressed suture **_Plagiolepis_** Mayr

– Metanotum not distinguished by sutures; metanotal furrow rounded and shallow **_Anoplolepis_** Santschi

## Genus **_Polyrhachis_** Smith

This is a genus of tropical arboreal ants with pronounced spiny ornamentation.

### Key to species

1. Petiole with developed lateral spines only. Propodeal spines long and curved **_simplex_** Mayr

– Petiole with two distinct median spines as well as lateral. Propodeal spines very short **_viscosa_** Smith

**_Polyrhachis simplex_** Mayr, 1863 (fig. 62)

*Polyrhachis simplex* Mayr, 1863; Verh. zool.-bot. Ges. Wien *28:* 682.

Al Qatif 14.IV.83; ☿☿ CAC. Oman: Khabura 27.VI.80; ☿ R.B. Whitcombe.

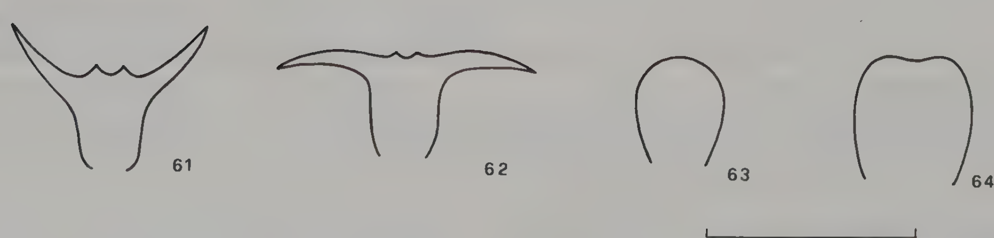
This is one of the commonest species of the genus in the Indian subcontinent and occurs also north of the tropics in Afghanistan, the Middle East and Morocco.

**_Polyrhachis viscosa_** Smith, 1858 (fig. 61)

*Polyrhachis viscosa* Smith, 1858; Cat. Hym. Brit. Mus. *6:* 71.

Fayfa semi-cultivated valley 31.III.83; 1 ☿ CAC.

This dense black species is recorded from both East and West tropical Africa. According to Bolton 1973, it is a savannah species nesting in sandy soil. The single worker at Fayfa was foraging on the soil surface under bushy scrub.




Figs 61–64: Petiole in posterior view. 61, *Polyrhachis viscosa* ☿; 62, *P. simplex* ☿; 63, *Camponotus oasium* ☿; 64, *C. thoracicus* ☿. (Scale bar 1 mm).

## Genus *Camponotus* Mayr

| List of species: | Geographical distribution: |
|---|---|
| *Camponotus acvapimensis* Mayr, 1862 | Tropical Africa |
| *Camponotus adenensis* Emery, 1925 | South Arabia |
| *Camponotus aegyptiacus* Emery, 1915 | North east Africa |
| *Camponotus alii* Forel, 1890 | North Africa |
| *Camponotus arabicus* n. sp. | Arabia |
| *Camponotus atlantis* Forel, 1890 | North Africa |
| *Camponotus baldaccii* Emery, 1894 | South east Europe |
| *Camponotus empedocles* Arnold, 1922 | Central & South Africa |
| *Camponotus fayfaensis n. sp.* | Saudi Arabia |
| *Camponotus fellah* Tohmé, 1969 | Egypt, Middle East |
| *Camponotus flavomarginatus* Mayr, 1862 | East Africa |
| *Camponotus hova* Forel, 1866 | Madagascar, Aldabra, Socotra |
| *Camponotus ilgii* Forel, 1895 | North east Africa |
| *Camponotus jizani* n. sp. | Saudi Arabia |
| *Camponotus kersteni* Gerstaecker, 1870 | East Africa |
| *Camponotus maculatus* (Fabricius, 1781) | Tropical Africa |
| *Camponotus oasium* Forel, 1890 | North Africa |
| *Camponotus schweinfurti* Forel, 1910 | South Arabia |
| *Camponotus sericeus* (Fabricius, 1798) | Africa, India, Middle East |
| *Camponotus thales* Forel, 1910 | North & South east Africa |
| *Camponotus thoracicus* (Fabricius, 1804) | North Africa |
| *Camponotus xerxes* Forel, 1904 | Central Asia, Middle East |

*Camponotus* species are very diverse in size and form. The majority of species depend on Homoptera exudates as a main source of food. Major workers of the larger species appear very formidable and their mandibles can cut through the skin easily.

### Key to species (large workers only)

1. In profile, dorsal outline of alitrunk interrupted by a deep metanotal furrow ........ 2
– In profile, dorsal outline of alitrunk seen as a more or less continuous curve ........ 4

2.(1) Whole body densely sculptured, hairy and opaque; propodeum broadly dentate posteriorly **sericeus** (Fabricius)
– Body weakly sculptured, moderately shining with sparse hairs; propodeum obtusely rounded posteriorly. (head with shallow round punctures) ........................ 3

3.(2) Gaster testaceous, contrasting with brown alitrunk and head ***fayfaensis*** n. sp.
– Gaster dark, unicolorous with rest of body; head sometimes reddish brown ***ilgii*** Forel

4.(1) Gaster dull with close pubescence .............................................. 5
– Gaster more or less shining with dilute pubescence ........................... 6

5.(4) Gaster with long thick silvery pubescence with a distinct longitudinal pattern on each side of the median line, head and body uniformly dark ***flavomarginatus*** Mayr

| | | | |
|---|---|---|---|
| – | Gaster with short pubescence, pattern if present appears as a single median furrow; genae yellowish red immediately above mandible insertions | ***jizani*** n. sp. | |
| 6.(4) | Gaster with distinct pattern of 2 or 3 yellow blotches | | 7 |
| – | Gaster with first gaster tergites either uniformly dark or yellowish or pale yellowish brown in part | | 8 |
| 7.(6) | Yellow blotches on gaster appear as a row of 2 or 3 discrete spots on either side; gula hairs numerous. Larger species, HW 3.6–3.75 mm, ♀ 3.1 mm | ***maculatus*** (Fabricius) | |
| – | Three yellow blotches on each side of gaster dorsum merge into each other laterally giving an irregular banded effect; gula hairs present but not numerous. Smaller species HW 3.5 mm or less, ♀ HW 2.7 mm | ***aegyptiacus*** Emery | |
| 8.(6) | Colour uniformly brown to brownish black, legs paler | | 9 |
| – | At least lower part of posterior mesosoma and scale testaceous | | 14 |
| 9.(8) | Occiput viewed in full face with at least one seta at each corner | ***acvapimensis*** Mayr | |
| – | Occipital hairs if present restricted to median area | | 10 |
| 10.(9) | Gula hairs very sparse or absent; legs yellow | ***adenensis*** Emery | |
| – | Gula hairs always present; legs pale brown or testaceous | | 11 |
| 11.(10) | Gaster dorsum without pubescense, whole body very shining | ***thales*** Forel | |
| – | Gaster with sparse pubescence, body duller with some sculpture | | 12 |
| 12.(11) | Hind tibiae channeled with a few spiny hairs on flexor surface and short decumbent pubescence evenly distributed round whole appendage | ***empedocles*** Arnold | |
| – | Hind tibiae not channeled with a few subdecumbent hairs only and sparsely distributed pubescence | | 13 |
| 13.(12) | Larger species HW 2.4–3.2 mm; gaster tergite margins with narrow pale bands; legs pale brown | ***kersteni*** Gerstaecker | |
| – | Smaller species, maximum HW less than 2.4 mm; gaster uniformly dark; legs testaceous | ***schweinfurti*** Forel | |
| 14.(8) | Hind tibiae with a row of 8 or more spiny hairs on flexor surface | | 15 |
| – | Hind tibiae with hairs either fine and subdecumbent or restricted to distal end | | 20 |
| 15.(14) | Gula hairs present | | 16 |
| – | Gula without hairs | | 18 |
| 16.(15) | Gula hairs abundant; alitrunk pale or with slight promesonotal infuscation; smaller species HW 3.3 mm or less | ***baldaccii*** Emery | |
| – | Gula hairs sparse, up to 6 at most; alitrunk mainly brown or brownish black: HW 4.0 mm or more | | 17 |
| 17.(16) | Large workers have whole dorsum of alitrunk and whole gaster brownish black. Maximum HW 4.5 mm | ***fellah*** Tohmé | |
| – | Large workers have most of alitrunk and base and sides of first gaster tergite irregularly pale yellowish brown; Maximum HW less than 4 mm | ***hova*** Forel | |
| 18.(15) | Large workers almost entirely black except for legs and lower part of petiole. ♀ propodeum unicolorous dark with rest of alitrunk | ***xerxes*** Forel | |
| – | Large workers with at least lower part of alitrunk and scale pale brown or testaceous; ♀ propodeum testaceous | | 19 |
| 19.(18) | First gaster tergite with basal two thirds testaceous; dorsum of petiole steeply rounded | ***oasium*** Forel | |
| – | First gaster tergite with small patch at base testaceous; dorsum of petiole widely rounded to flat | ***thoracicus*** (Fabricius) | |

20.(14) First gaster tergite and petiole pale yellow ***atlantis*** Forel
– Body colour variable without distinctive pattern .............................. 21
21.(20) Gula hairs abundant; gaster with scattered dorsal pubescence and somewhat dull ***arabicus*** n. sp.
– Gula hairs sparse; gaster with very sparse pubescence, intensely shining ***alii*** Forel

***Camponotus acvapimensis*** Mayr, 1862

*Camponotus acvapimensis* Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 664.

Socotra: Adho Dimellus IV.69; ♂ ☿☿ ♀♀ K.M. Guichard. Jebel Al Alam 21.X.81; ☿ W. Büttiker.

This species is widely distributed throughout the savannahs and cleared forest areas of tropical Africa where it is a common daytime forager. It is a dark opaque species with dark appendages and further characterised by the fringe of occipital hairs and the presence of abundant dorsal and gula hairs.

***Camponotus adenensis*** Emery, 1925 n. stat.

*Camponotus maculatus* ssp. *thraso* var. *adenensis* Emery, 1893; Annls. Soc. ent. Fr. *62:* 257.
*Camponotus thraso* var. *adenensis* Emery, 1925: 92.

Fayfa tamarisk grove 27.III.83; Fayfa hillside 28.III.83; Al Qahman mangrove swamp 1.IV.83; ☿☿ CAC. Hakimah 22.IX.81; ☿☿ W. Büttiker.

This is a small dark brown species with yellow to reddish yellow legs. Gula hairs are either absent or reduced to three or four at most towards the posterior part of the head. Both head and alitrunk are finely sculptured and opaque with the gaster more shining. HW of largest worker 2.4 mm. The hind tibiae lack spiny bristles but a fringe of very short suberect pubescent hairs runs the length of the tibial underside. *C. thraso* Forel is a bicoloured Indian species according to named examples in the Forel collection where there is an example of *C. adenensis* labelled type which matches the Saudi Arabian material. *C. adenensis* was described and recorded from the one locality, Aden.

***Camponotus aegyptiacus*** Emery, 1915

*Camponotus maculatus* ssp. *aegyptiaca* Emery, 1915; Bull. Soc. ent. Fr. (1915): 79.
*Camponotus aegyptiacus.* – Baroni Urbani, 1972; Verhandl. naturf. Ges. Basel *82* (1): 130.

Jeddah 20.V.75; Khaybar 26.V.79; Wadi Shugub 21.IV.80; Talaa 23.IX.80; Wadi Talham 27.IX.80; Wadi Majarish 2.I.82; Wadi Horash 29.IX.80; Wadi Nimar 20.V.83; Uqdah 26.VIII.83; Wadi Ellah 9.IX.83; Wadi Dhyan 14.IX.83; Wadi Aridah 20.IX.83; Harithi 27.I.84; ♂♂ ☿☿ ♀♀ W. Büttiker. Al Kharj desert 23.III.83; Al Kharfa desert 24.III.83; Abu Arish 25.III.83; Sug al Ahad 26.III.83; Fayfa 27.III.83; 30.III.83; Sulaiel desert 11.IV.83; Al Qatif coast 14.IV.83; ♂♂ ☿☿ ♀♀ CAC.

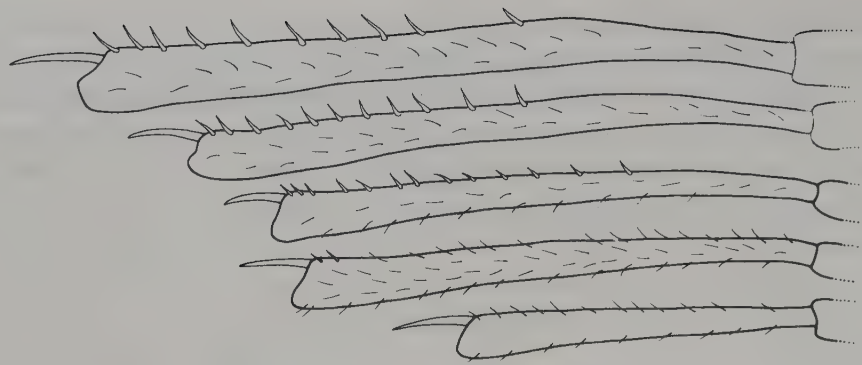
This is a common North east African species. This species is mainly active at night when individuals may be seen flitting rapidly over the ground in search of food. The minor workers are very pale.

***Camponotus alii*** Forel, 1890

*Camponotus rubripes* st. *alii* Forel, 1890; Annls. Soc. ent. Belg. *34:* 61.
*Camponotus alii.* – Emery, 1920; Bull. Soc. ent. ital. *52:* 7.

Anamas 8.IV.83; Al Tawlah 7.IV.83; ☿☿ ♀ CAC.

The colour of this North African species varies with the alitrunk ranging from red to black in the larger workers. It is common in the Atlas mountains of North Africa.




Figs 65–69: Hind tibia of *Camponotus.* 65, *C. xerxes* ☿; 66, *C. hova* ☿; 67, *C. arabicus* ☿; 68, *C. empedocles* ☿; 69, *C. kersteni* ☿. (Scale bar 1 mm).

***Camponotus atlantis*** Forel, 1890

*Camponotus rubripes* st. *atlantis* Forel, 1890; Annls. Soc. ent. Belg. *34:* 83.

*Camponotus atlantis.* – Emery, 1925: 91.

Al Farrash 15.X.82; ☿☿ W. Büttiker. Fayfa hillside 29.III.83; Wadi Shugub 7.IV.83; ☿☿ ♀ CAC. Yemen: Colline Khazain, Wadi Magsala XI.79; ☿☿ Borri & Poggesi (B. Lanza).

These ants are characterised by the yellow blotch on the gaster which extends over the first and second tergites. It is similar in size, structure and pilosity to *C. alii* but differs in the denser sculpture of the head and promesonotum and generally much paler colour, the minor workers being almost completely yellow. Colonies were under stones on hillside terraces. Like *C. alii* this species is general in the mountains of North Africa.

***Camponotus arabicus*** n. sp. (figs 67, 72, 74)

Riyadh Agricultural Centre 30.I.80; ☿☿ ♀♀ A.S. Talhouk. Riyadh Agricultural Centre 19.IV.83; ☿☿ ♀ CAC. Oman: Qaboos 4.XI.83; ♀♀ M. Gallagher.

This is similar to *Camponotus alii* Forel but has more profuse gula hairs and a more sculptured gaster with closer pubescence. It differs also in colour. The smaller workers have the alitrunk pale yellowish brown while only the largest workers have the alitrunk dorsum dark.

Holotype major worker: TL 11.2; HL 2.95; HW 3.13; SL 2.25; EL 0.40; CI 106; SI 72.

Head, alitrunk and gaster are dark brownish black; the funiculus, legs, petiole, base of the propodeum and an indefinite patch on the basal face of the gaster are testaceous. The head and alitrunk are opaque with close reticulate microsculpture. The gaster is finely cross striate with pubescence evenly scatttered over the whole surface giving a much duller appearance than that of *C. alii.* In profile 10 hairs may be seen evenly distributed over the gula surface. The moderately flattened hind tibiae bear two spinules and 14 subdecumbent short hairs on the flexor surface. Long hairs are scattered over the whole dorsum.

The antennal scapes are short, barely reaching the occipital margin. The dorsal outline of the alitrunk is evenly curved. The petiole scale is thin in profile with a convex anterior face. The clypeus is keeled and projects forward as a rectangular plate.

The minor workers are wholly yellowish with only the head dorsum and the gaster apex darker.

The queens are dark like the major worker with the head similarly sculptured. The mesoscutum and scutellum are smooth and shining. The gaster dorsum is less sculptured than in the large workers.

The head is slightly longer than broad with a mildly concave occipital margin. HL 2.75; HW 2.6; SL 3.0; CI 94.8; SI 115.4; Gula and appendage pilosity as in the worker.

This is a nocturnal species, somewhat fugitive, living in small colonies at the base of date palms. Alate queens were in the nests in November and January according to captures by M. Gallacher and A.S. Talhouk respectively.

Holotype worker, paratype workers and paratype queens from Riyadh in NHMB.

***Camponotus*** sp.

Abu Arish resthouse grounds 26.III.83; ☿☿ CAC.

This series of small dark brown workers were taken tending Homoptera on shrubs. This species is similar to *C. adenensis* in size and colour but differs in having a number of gula hairs always present, a more decumbent and shorter tibial pubescence and a relatively longer alitrunk. Workers closely match specimens in the Forel collection, Geneva, named *C. schweinfurti* (*Camponotus maculatus* ssp. *negus* var. *schweinfurti* Forel, 1910: 453) from the type locality, Menakka 1.XII.87 in Arabia. This varietal name is at present unavailable until further study establishes the status of *Camponotus maculatus* ssp. *negus* Forel although it should be stated that *C. schweinfurti*, a name I have used in the keys, is in no way at all similar to or related to *C. maculatus*.

***Camponotus baldaccii*** Emery, 1894 n. stat.

*Camponotus dichrous* var. *baldaccii* Emery, 1894; Bull. Soc. ent. ital. *26:* 9.

*Camponotus sylvaticus* ssp. *baldaccii*. – Emery, 1920, Bull. Soc. ent. ital. *52:* 6.

Hadda XI. 38; ☿☿ H.S.J.A. Philby. Hesua 29.VIII.82; ☿☿ W. Büttiker.

This is linked to *C. sylvaticus* Ol. of South west Europe by its pilosity characters but is distinguished by its yellow alitrunk from the reddish to black *C. sylvaticus*, its less robust appearance and smaller size. Its main area of distribution is in the Greek Islands and Turkey. True *C. sylvaticus* is not found east of Italy. *C. baldaccii* males are pale testaceous in contrast to the black much more robust males of *C. sylvaticus*.

***Camponotus empedocles*** Arnold, 1922 n. stat. (fig. 68)

*Camponotus maculatus* r. *thales* var. *empedocles* Forel, 1913; Dt. ent. Z. (1913): 224.

*Camponotus maculatus* ssp. *empedocles* Arnold, 1922; Ann. S. Afr. Mus. *14:* 645.

Anamas 2280 m IV. 80; Wadi Azizah 18.IX.83; Wadi al Amar 2000 m 18.IX.83; Wadi Majarish 22.III.82; ☿☿ ♀♀ W. Büttiker. Anamas 8.IV.83; Tanuma 8.IV.83; ♂♂ ☿☿ ♀♀ CAC.

This is the largest of the black *Camponotus* species found, HW 3.3–3.4 mm. The queen caste has the scapes and tibiae clothed with raised pubescence. This is less evident in the worker and male but is thicker and more abundant than in the other black species. Since *C. empedocles* neither resembles *C. maculatus* nor *C. thales*, it is clearly a distinct species. It was described from the mountains of Central South Africa. The Arabian locations are all from the higher areas of the Asir mountains.

***Camponotus fayfaensis*** n. sp. (fig. 70)

Fayfa wooded valley 27.III.83; ☿☿ CAC.

A column of workers was seen ascending a tree from its base in scattered single file at a rapid pace in early evening. The distinctive colour constrast between the testaceous gaster and the brown head and alitrunk coupled with the deep metanotal groove as in *C. ilgii* was not matched by any species seen in BMNH, NHMB or the Geneva collections.

Holotype worker: TL 3.7; HL 1.2; HW 1.1; SL 1.14; EL 0.38; CI 91.7; SI 103.6.

Head and alitrunk brown, whole gaster and legs testaceous forming a distinct colour contrast. A fringe of hairs is present on the dorsum of the petiole scale and on the posterodorsum of the propodeum; two hairs are present on the mesonotum and two on the pronotum. The occiput has very short subdecumbent hairs. There are no gula or appendage hairs. The whole body is moderately shining with sparse pubescence. The ventral and front part of the head including the clypeus has widely spaced shallow punctures. The promesonotum has the dorsal outline an even curve, separated from the rounded propodeum by a wide metanotal groove. The scale is thin in profile with a convex anterior face and a rounded dorsum.

This species belongs to the same group as *C. ilgii* Forel in the *C. foraminosus* Forel species complex and would be easily recognised by the distinctive colour and the wide metanotal groove.

Holotype and paratypes in NHMB.

Fig. 70: *Camponotus fayfaensis* ☿, profile view.

***Camponotus fellah*** Tohmé, 1969

*Camponotus maculatus* r. *oasium* var. *fellah* Emery, 1891; Explor. Sc. Tunisie Formic.: 18.

*Camponotus fellah* Tohmé, 1969; Doctorate thesis University of Toulouse: 13.

*Camponotus fellah*. – Pisarski, 1971; Bull. Acad. pol. Sci. CLVI *19* (11): 728.

Wadi Karrrar 4.VIII.81; ☿☿ W. Büttiker. Al Qatif 16.IV.83; ♂ ☿☿ CAC. Oman: Khabura 17.III.78; 4.II.80; 31.VII.80; ☿☿ R.P. Whitcombe.

The major workers of this species are large, HW up to 4.5 mm and almost entirely black apart from the appendages, lower part of propodeum and petiole. They are only distinguishable from the similar *C. xerxes* by the presence of a few gula hairs in all castes. The minor workers are much paler than the large workers and in this differ from the common and even larger *C. compressus* (Fabricius) of India where workers of all sizes are dark and in addition have more abundant gula hairs. *C. fellah* is recorded from Egypt, Palestine and Syria but has also occurred in Afghanistan according to Pisarski (1971).

***Camponotus hova*** Forel, 1866 (fig. 66)

*Camponotus hova* Forel, 1866; Annls. Soc. ent. Belg. *30:* 150.

Socotra; Adho Dimellus IV.69; ☿☿ K.M.Guichard. Oman: Afrad Batina, Khabura 3.II.80. ☿☿ R.P. Whitcombe.

This species links the *C. thoracicus* species group with *C. maculatus*. Gula hairs are always present as in *C. maculatus* but the first gaster tergite is mainly testaceous and does not have clearly demarcated pale spots. This species is recorded from Aldabra, Mozambique and Madagascar.

***Camponotus flavomarginatus*** Mayr, 1862

*Camponotus flavomarginatus* Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 664.

Anamas 8.IV.83; Sawdah mountain 9.IV.83; ☿☿ CAC.

This is a distinctively patterned pubescent species in the *C. rufoglaucus* (Jerdon) complex. The gaster pubescence is close and thick and so arranged as to give the appearance of two shallow longitudinal furrows at each side of the middle dorsum. The tibiae are more flattened than in the North African *C. micans* which this species resembles in size and dark colour but not in the patterned pubescence. A small troop of workers was seen moving over stony ground in full daylight on Sawdah mountain at 3000 m. The species was described and recorded from East Africa.

***Camponotus ilgii*** Forel, 1895

*Camponotus ilgii* Forel, 1895; Mitt. schweiz. ent. Ges. *9:* 64.

Fayfa 28.III.83; 29.III.83; 30.III.83; Al Qahman 1.IV.83; ☿☿ CAC.

This species has the front part of the head more or less closely set with large shallow punctures as in *C. foraminosus* Forel but differs from that species and its allies by the deep impression between mesonotum and propodeum. It is exclusively arboreal nesting in sections of rotten wood on old trees. Single workers were often seen among files of *Crematogaster affabilis* workers in the same way as the European *Camponotus lateralis* Ol. is often associated with *Crematogaster scutellaris* Ol. presumably as a form of protection from predators.

***Camponotus jizani*** n. sp. (fig. 71, 73)

Abu Arish (near Jizan) 25.III.83; Fayfa 27.III.83; Fayfa hillside 28.III.83; Fayfa resthouse environs 30.III.83; Abu Arish resthouse environs 3.IV.83; Khamis al Bhar 4.IV.83; ☿☿ CAC.

This is a small dark species with a dull pubescent gaster and reddish yellow genae that was found to be locally abundant in the far south west of the country. It is a ground nester that forages actively in daylight hours and was frequently seen tending Homoptera on shrubs.

Holotype worker major: TL 7.0; HL 2.02; HW 2.00; EL 0.43; CI 99; SI 103.

Colour dark brownish black with the genae below the eyes and immediately above the mandibles reddish yellow. A few long hairs are present on the dorsum of the head, alitrunk and gaster. Two to four gula hairs are generally present but the tibiae and scapes are hairless apart from short decumbent pubescence. Decumbent pubescence covers the whole body and is thicker on the gaster where in unworn specimens it is so arranged as to give an appearance of a shallow median furrow along the first two tergites. The mandibles and front part of the projecting keeled clypeus have wide spaced punctures. The head is almost as broad as long but narrows anteriorly. The occipital margin is feebly emarginate. The mandibles bear five strong teeth. The antennal scapes over-reach the occiput by about the length of the first funiculus segment. The alitrunk is evenly and obliquely curved with the dorsal outline broken by a small promesonotal suture. The petiole is simple with a mildly convex anterior face. The tibiae nearly cylindrical, not flattened or channelled.

The smaller workers have the head progressively elongate and narrowing in front of the eyes with the occiput progressively convex as size diminishes.

Holotype and paratypes in NHMB.

***Camponotus kersteni*** Gerstaecker, 1870 (fig. 69)

*Camponotus kersteni* Gerstaecker, 1870; Arch. Naturgesch. *37:* 355.

Al Qatif date palms 14.IV.83; ♂ ☿☿ CAC.

This East African species is similar to *C. empedocles* but not so large, HW 2.4–3.1 mm. The append-

ages are less thickly pubescent but the gaster dorsum is more opaque with denser microsculpture and closer pubescence. A colony was found nesting under date palm litter.

### ***Camponotus maculatus*** (Fabricius, 1781)

*Formica maculata* Fabricius, 1781; Spec. Insect. *1:* 491.

*Camponotus maculatus* (Fabricius) Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 654.

This afrotropical species was recorded from Aden by Emery (1881) but no examples from Arabia have been seen during the present study.

### ***Camponotus oasium*** Forel, 1890 (fig. 63)

*Camponotus rubripes* st. *oasium* Forel, 1890; Annls. Soc. ent. Belg. 34: 65.

*Camponotus oasium.* – Collingwood, 1960: 75.

Wadi Khamra near Khaybar V. 78; ☿☿ KAU-NHMB expedition. Oman: Montasar 15.XII.81; ☿ M. Galllagher.

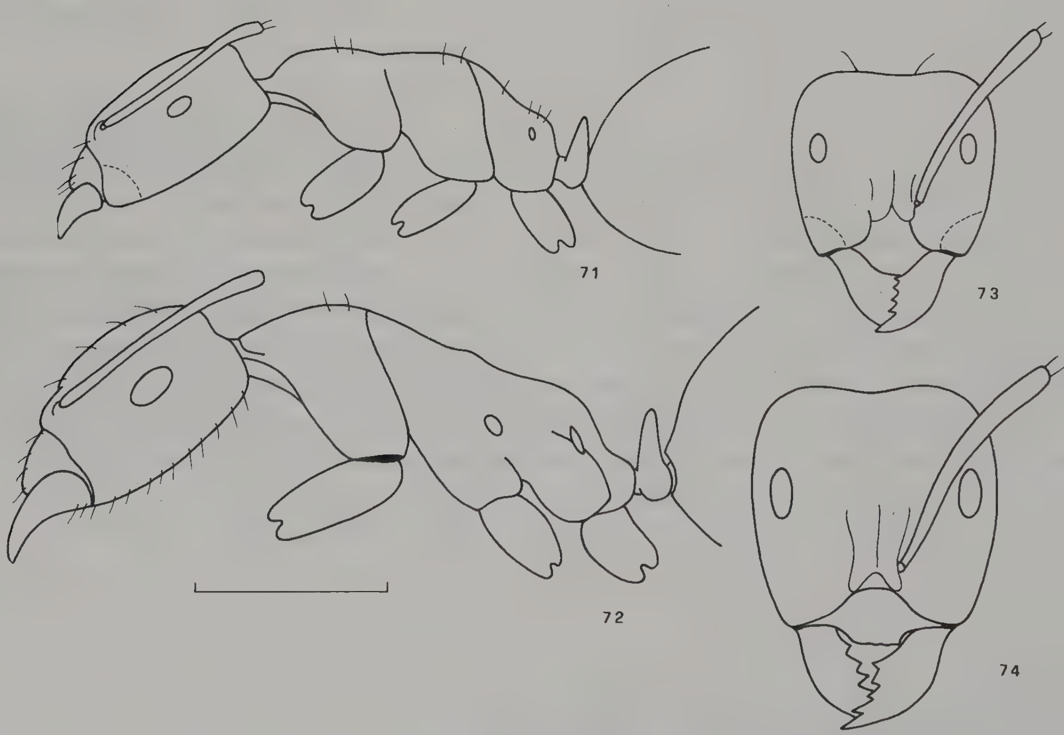
This North African species differs from the similar *C. thoracicus* (Fabricius) in the narrower more convex petiole and the occasional presence of one or two gula hairs.

### ***Camponotus sericeus*** (Fabricius, 1798)

*Formica sericea* Fabricius, 1798; Suppl. Ent. Syst.: 279.

*Camponotus sericeus* (Fabricius) Mayr, 1862; Verh. zool.-bot. Ges. Wien *12:* 675.

Wadi Araida 5.IX.75; Wadi Hanifa 30.I.76; Bir Hammi IV.80; Wadi Drady 1.V.80; Dammam 12.X.82; Wadi Majarish 7.I.83; Wadi Bani Malek 8.II.83; Wadi Dhyan 13.IX.83; Bani Musayqirah




Figs. 71, 72: Profile view of *Camponotus*. 71, *C. jizani* ☿; 72, *C. arabicus* ☿. Figs 73, 74: Head in dorsal view. 73, *Camponotus jizani* ☿; 74, *C. arabicus* ☿. (Scale bar 1 mm).

20.IX.83; Usfan 29.XII.83; ♂ ☿☿ W. Büttiker. Riyadh 25.VIII.81; ☿ M. Ghani. Near Makkah 6.IX.80; ☿☿ P. Gasparetti. Riyadh 10.I.80; ☿☿ ♀♀ A.S. Talhouk. Riyadh 22.III.83; Najran 24.III.83; Abu Arish 26.III.83; Sug al Ahad 26.III.83; Fayfa 29.III.83; 30.III.83; Karm Rauisch 5.IV.83; Wadi Qust 7.IV.83; Al Kola 10.IV.83; ☿☿ ♀♀ CAC. Oman: Dhofar 2.XI.83; ☿ M. Gallagher. Khabura Batina 27.I.80; ☿☿ R.P. Whitcombe.

This is the most widespread of the Arabian *Camponotus* species, occurring throughout the Indian subcontinent, savannah Africa and the Middle East. It is a hardy daytime forager and as with most *Camponotus* species tends coccids on trees and shrubs.

### *Camponotus thales* Forel, 1910

*Camponotus maculatus* ssp. *thales* Forel, 1910; Annls. Soc. ent. Belg. *54:* 453.

*Camponotus thales.* – Emery, 1920; Bull. Soc. ent. ital. *52:* 6.

Wadi Azizah 18.IX.83; ☿ W. Büttiker. Anamas 8.IV.83; Sawdah mountain 9.IV.83; ☿☿ ♀ CAC.

This is the most brilliantly shining of the black species. The gaster almost entirely lacks pubescence or surface sculpture. Its known distribution is somewhat scattered from Morocco in North Africa to Basutoland far to the south.

### *Camponotus thoracicus* (Fabricius, 1804) (fig. 64)

*Formica thoracica* Fabricius, 1804; Syst. Piez.: 397.

*Camponotus thoracicus* (Fabricius) Roger, 1862; Berl. ent. Z. *6:* 285.

Dafina 20.IX.31; Hofuf 5.I.32; ♂ ♀♀ H.S.J.B. Philby. Riyadh 14.III.75; 14.VIII.75; 9.I.76; Wadi Shugub 7.IV.80; Al Dahlan 20.I.80; Bokhara 14.IX.80; Jebel al Alam 21.X.81; ♂♂ ♀♀ W. Büttiker.

### *Camponotus xerxes* Forel, 1904 (fig. 65)

*Camponotus maculatus* st. *xerxes* Forel, 1904; Annls. Soc. ent. Belg. *48:* 424.

*Camponotus xerxes.* – Pisarski, 1967; Annls. Zool. Warsz. *24:* 414.

Al Ula 20.V.78; ☿☿ KAU-NHMB expedition. Araida 9.X.75; Wadi Hanifa 7.V.76; Dammam 18.V.78; Kushm Dibi 20.V.78; Al Khubra 29.V.78; Hofuf 28.IX.78; Quwayiyah 1.III.79; Al Kharj 2.IV.80; Al Khardj 21.VI.80; Wadi Jureisi 30.V.80; Wadi Shugub 6.IV.80; Wadi Batayn 22.IV.80; Khashm Khafs 6.VI.80; Ashayrah 15.VIII.80; Um ad Dabal 13.V.80; Wadi Qatan 20.IX.80; Al Khardj 21.VI.80; Sanam 28.VIII.80; Shanib 20.IX.80; Jebel Bukysal 12.IX.80; Sal al Binat 24.IV.80; Hama 18.IX.81; ♂♂ ☿☿ ♀♀ W. Büttiker. Riyadh 14.I.80; 16.I.80; 18.I.80; 21.I.80; ♂♂ ☿☿ ♀♀ A.S. Talhouk. Riyadh 22.III.83; Sug al Ahad 26.III.83; Al Tawlah 7.IV.83; Wadi Shugub 7.IV.83; Hofuf 13.IV.83; Hair 17.IV.83; ♂♂ ☿☿ ♀♀ CAC.

The first Arabian record for this large conspicuous ant was from Muscat (Forel 1904). The major workers are large like *C. fellah,* maximum HW up to 4.5 mm and can bite fiercely. Most foraging is during the early evening. Arabia is probably the western limit for this wide ranging Central Asian species. In North Africa various other species of the *C. thoracicus* complex take over including *C. thoracicus* itself, *C. oasium* and *C. martensi* Forel all of which have the largest workers paler than *C. xerxes* with more or less extended areas of testaceous yellow or pale brown on the lower mesosoma, propodeum and first gaster tergite. Some authors e.g. Emery (1925) link this species to *C. compressus* (Fabricius) of India but that species is larger, HW up to 5 mm, always has gula hairs while the smaller workers unlike all members of the *C. thoracicus* complex, are as dark as the larger. The smaller workers of *C. xerxes* have the alitrunk dull testaceous and are hard to distinguish from *C. thoracicus,* but males, queens and major workers are all considerably darker than the corresponding castes of *C. thoracicus.*

## Genus ***Cataglyphis*** Foerster

| List of species: | Geographical distribution: |
|---|---|
| *Cataglyphis abyssinica* (Forel, 1904) | North east Africa |
| *Cataglyphis adenensis* (Forel, 1904) | South Arabia |
| *Cataglyphis albicans* (Roger, 1859) | North Africa, Middle East |
| *Cataglyphis asiriensis* n. sp. | Saudi Arabia |
| *Cataglyphis desertorum* (Forel, 1894) | North Africa, Sahara |
| *Cataglyphis diehli* (Emery, 1906) | North Africa |
| *Cataglyphis emmae* (Forel, 1909) | North Africa |
| *Cataglyphis isis* Pisarski, 1967 | Suez |
| *Cataglyphis laevior* Stitz, 1916 | North Africa |
| *Cataglyphis livida* (André, 1881) | Middle East, Arabia |
| *Cataglyphis minima* n. sp. | Saudi Arabia |
| *Cataglyphis niger* (André, 1882) | Middle East |
| *Cataglyphis nodus* (Brullé, 1832) | Middle East, South east Europe |
| *Cataglyphis rubra* (Forel, 1903) | North Africa |
| *Cataglyphis sabulosa* Kugler, 1981 | Sinai, Palestine |
| *Cataglyphis saharae* Santschi, 1929 | North Africa |
| *Cataglyphis semitonsa* Santschi, 1926 | North Africa |
| *Cataglyphis urens* n. sp. | Arabia |

This genus includes species that are highly adapted to desert conditions. All the species bear long ammochoete hairs on the anterior gula surface and long palps with which they are able to dig out channels in loose sand. Nests of the larger species are usually sited at the foot of a bush or at the bottom slope of a sand hill. Individuals forage singly, darting rapidly across hot stones and sand during the heat of the day. Délye (1968) has shown that *Cataglyphis* may survive temperatures of 50 °C for at least one hour whereas species of most other genera would succumb rapidly.

Behaviour and orientation studies have been carried out by Harkness & Wehner (1977) who have shown that with their large eyes and wide angled vision, these ants direct their course by polarised celestial light as well as by remembered landmarks.

Taxonomically this is one of the more difficult groups since differences between geographically separate populations of like forms within a species group may be apparent but often slight. Santschi in his review of the genus enumerated 28 forms within the *Cataglyphis bicolor* (Fabricius) group (Santschi 1929). All of these were keyed but treated as races (stirpes) or varieties. In this paper all recognisably different forms so far found in Arabia within this group are treated as good species.

### Key to species

| | | |
|---|---|---|
| 1. | Petiole a truncated node with a flat dorsal surface sloping forward (*C. albicans* group) . | 2 |
| – | Petiole a rounded node or an upright thick scale . . . . . . . . . . . . . . . . . . . . | 6 |
| 2.(1) | Colour uniformly shining black . . . . . . . . . . . . . . . . . . . . . . . . . . . | 3 |
| – | Head and alitrunk yellow or reddish at least in part . . . . . . . . . . . . . . . . | 4 |
| 3.(2) | Head width of large workers 2 mm or more; queen HW 1.85 mm **albicans** (Roger) | |
| – | Head width of large worker less than 1.2 mm; queen HW 1.62 mm **minima** n. sp. | |

4.(2) Head and alitrunk reddish brown, sculptured and somewhat dull ***semitonsa*** Santschi
– Head and alitrunk bright yellow or yellowish red . . . . . . . . . . 5
5.(4) Bicoloured with gaster tergites 2 to apex infuscate; dorsum of alitrunk with an occasional erect hair or none; whole body brilliant with only sparse pubescence restricted to lower mesosoma ***rubra*** (Forel)
– Body uniformly yellow, dorsum of pronotum, propodeum and node always with some erect hairs; whole body shining but finely sculptured and not brilliant; sides of mesonotum and propodeum with distinct pubescence ***livida*** (André)
6.(1) Petiole in profile an upright scale . . . . . . . . . . 7
– Petiole in profile a more or less thick rounded node . . . . . . . . . . 8
7.(6) Colour yellowish brown; gaster frequently paler; third maxillary palp fringed with long curved hairs ***sabulosa*** Kugler
– Colour uniformly brownish black; third maxillary palp without conspicuously long hairs ***emmae*** (Forel)
8.(6) Maxillary palps short, segment 4 shorter than 5 + 6; whole dorsum with short thick hairs. (*C. viaticus* group) Colour except for tarsi entirely black ***asiriensis*** n. sp.
– Maxillary palps long, segment 4 longer than 5 + 6; dorsal hairs scattered, long and fine. (*C. bicolor* group) . . . . . . . . . . 9
9.(8) Colour mainly black . . . . . . . . . . 10
– Bicoloured species with head and alitrunk red or dull brownish red . . . . . . . . . . 12
10.(9) Node thick, about as high as long; first funiculus segment nearly x 2 as long as second. Larger species TL up to 12 mm ***niger*** (André)
– Node higher than long in profile; first funiculus segment less than x 1.4 as long as second. Smaller species maximum length about 9.5 mm . . . . . . . . . . 11
11.(10) Gaster brilliant; antennal scape without erect hairs; alitrunk pubescence sparse; colour entirely black ***diehli*** (Emery)
– Gaster with first tergite sculptured; antennal scape often with a few fine erect hairs; alitrunk pubescence dense; mid body occasionally brown in smaller specimens ***isis*** Pisarski
12.(9) Head wider than long ***adenensis*** (Forel)
– Head longer than wide . . . . . . . . . . 13
13.(12) Gaster dorsum shining. Antennal scapes with some erect hairs . . . . . . . . . . 14
– Gaster sculptured, somewhat dull. Scapes without erect hairs . . . . . . . . . . 15
14.(13) Occiput shining, gaster brilliant; node higher than long, often infuscated contrasting with red alitrunk. First funiculus segment x 1.3 as long as second ***laevior*** Stitz
– Occiput dull, gaster shining but not brilliant; node unicolorous red with alitrunk. First funiculus segment about x 1.7 as long as second ***saharae*** Santschi
15.(13) Node low, longer than high in profile . . . . . . . . . . 16
– Node as high as long in profile . . . . . . . . . . 17
16.(15) Propodeum high, the dorsal and descending faces forming a rounded right angle. Head and alitrunk bright red; appendages brownish red ***urens*** n. sp.
– Propodeum low obliquely rounded. Head and alitrunk dark red; legs with coxae and femora dark brown ***abyssinica*** (Forel)
17.(15) Head and alitrunk brownish red. Petiole with anterodorsal slope somewhat flattened ***desertorum*** (Forel)
– Head and alitrunk generally clear red. Petiole a large rounded dome ***nodus*** (Brullé)

**Cataglyphis abyssinica** (Forel, 1904) n. stat.

*Myrmecocystus viaticus* st. *abyssinica* Forel, 1904; Annls. Mus. zool., St. Petersbourg *8:* 282.
*Cataglyphis bicolor* st. *abyssinica* (Forel) Santschi, 1929: 52.

Abu Arish stony ground outside resthouse compound 3.IV.83; ☿☿ CAC.

These are characterised by the long low petiole and obliquely rounded propodeum. The petiole is longer in profile than it is high and clearly differentiates this as a distinct species from *C. bicolor* which has a more massive dome-like node. This species was described and recorded from North east Africa.

**Cataglyphis adenensis** (Forel, 1904)

*Myrmecocystus viaticus* st. *adenensis* Forel, 1904; Annls. Mus. zool., St. Petersbourg *8:* 282.
*Cataglyphis adenensis* (Forel) Santschi, 1929: 41.

The type was described from Aden. It is said to have the head wider than long unlike other members of the *C. bicolor* species group and a high narrow petiole. No sample ascribable to this form was collected. Two specimens in the Santschi collection at NHMB standing under the name of *C. adenensis* appear to belong to the *C. albicans* species group.

**Cataglyphis albicans** (Roger, 1859)

*Formica albicans* Roger, 1859; Berl. ent. Z. *3:* 235.
*Cataglyphis albicans* (Roger) Roger, 1863; Verz. Formicid.: 12.

Zahran 25.III.83; Mahaiel 4.IV.83; Anamas 8.IV.83; Al Kola 10.IV.83; ♂ ☿☿ ♀♀ CAC.

The workers appear to be typical of this species which is widespread in North Africa and the Middle East. However there are differences in the male genitalia from different geographical populations that are yet to be resolved.

**Cataglyphis asiriensis** n. sp. (fig. 76)

Anamas 8.IV.83; Sawdah mountain 3000 m 9.IV.83; ☿☿ CAC.

This is a very distinctive ant, akin in general structure to *C. viaticus* (Fabricius) and allied species but at once recognisable from the remarkable development of stout black hairs all over the body and appendages.

Holotype worker: TL 8.3; HL 1.90; HW 1.65; EL 0.48; SL 2.00; CI 81; SI 121; ratio of first funiculus segment to the second 1.63; length of hind femur 1.63; length of hind tibia 3.50.

Colour entirely black except for pale tarsi. Head and alitrunk coarsely reticulate and matt; gaster very finely sculptured and somewhat shining. Whole dorsum of head, alitrunk and petiole clothed with stout black hairs. Hairs on gaster restricted to basal face of first gaster tergite and to third and remaining apical segments. Femora with similar stout hairs, shorter, subdecumbent and more crowded on tibiae. The fourth maxillary palp is slightly shorter than the third or the fifth plus sixth combined. The eyes are large and bulbous. The antennae are relatively long. The petiole is a high blunt triangular node, rounded at the top and higher than long in profile.

Foraging workers were taken singly on the open hillside at Anamas. Colonies were found under stones on Sawdah mountain. In one, *Thorictus* beetles were seen clinging to the worker scapes.

Holotype and paratypes from Sawdah mountain in NHMB.

**Cataglyphis desertorum** (Forel, 1894) n. stat. (fig. 83)

*Myrmecocystus viaticus* var. *desertorum* Forel, 1894; J. Bombay nat. Hist. Soc. *8:* 402.
*Myrmecocystus viaticus* ssp. *desertorum*. – Emery, 1898; Öfvers. finska Vetensk Soc. Förh. *20:* 23.

Wadi Jureisi 30.V.80; Dabah 12.V.80; Araida 21.II.75; Riyadh 15.I.80; Wadi Nimar V.83; ☿☿ W.

Büttiker. Karm Rauisch 5.IV.83; Al Qatif 14.IV.83; Hair desert 18.IV.83; ☿☿ CAC. Oman: Wattayah XI.83; ☿ M. Gallagher.

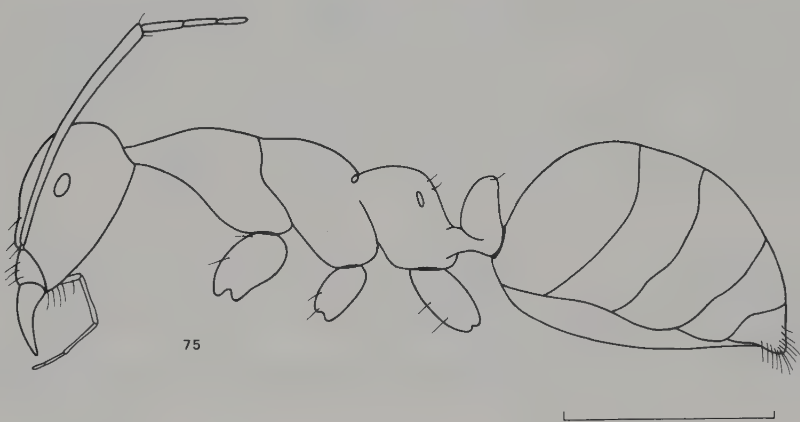
This is the dullest coloured of the reddish species allied to *C. bicolor* (Fabricius). The head and alitrunk are often brownish rather than red. The node is less massive than in *C. niger* (André) and has the anterodorsal face forming a flattened curve rather than an evenly rounded dome.

***Cataglyphis diehli*** (Emery, 1906) n. stat. (fig. 77)

*Myrmecocystus viaticus* ssp. *desertorum* var. *diehli* Forel, 1902; Annls. Soc. ent. Belg. *46:* 462.
*Myrmecocystus bicolor* ssp. *diehli* Emery, 1906; Memorie R. Accad. Sci. Ist. Bologna *3:* 184.
*Cataglyphis bicolor* st. *diehli* (Emery) Santschi, 1929: 56.

Wadi Khumra 10.II.83; ☿ W. Büttiker. Al Tawlah 7.IV.83; Hofuf sand mountain 13.IV.83; Al Qatif sandy desert 16.IV.83; ☿☿ CAC.

This shining black ant is also distinctive in having the funiculus segments shorter than in *C. bicolor* or *C. niger* and allied species. The first funiculus segment is about x 1.3 as long as the second compared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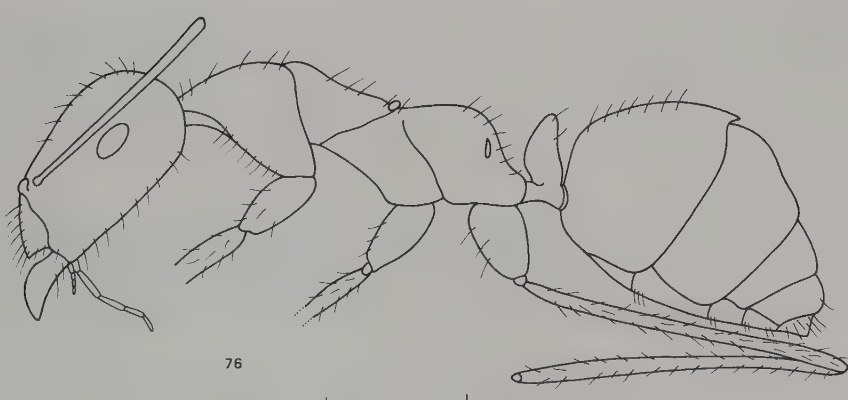
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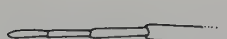
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Figs 75, 76: Profile view of *Cataglyphis*.75, *C. minima* ☿; 76, *C. asiriensis* ☿. Figs 77–80: Funiculus segments 1–3. 77, *Cataglyphis diehli* ☿; 78, *C. isis* ☿; 79, *C. saharae* ☿; 80, *C. niger* ☿. (Scale bar 1 mm).

with about x 1.8 as long in the *C. bicolor* group and on this character alone apart from the colour difference, cannot be regarded as a subspecies of *C. bicolor.*

***Cataglyphis emmae*** (Forel, 1909) (fig. 87)

*Formica (Proformica) emmae* Forel, 1909; Bull. Soc. vaud. Sci. nat. *45:* 381.

*Cataglyphis emmae* (Forel) Santschi, 1929: 30.

Zahran semi-cultivated area 25.III.83; ☿☿. Al Qatif 14.IV.83; 1 ♀ CAC.

These are interesting locality records for a species that has been linked previously with North African desert habitats. The colony at Zahran was located under a stone and the workers from their slow movements were at first thought to belong to the genus *Proformica.* It is somewhat aberrant species within *Cataglyphis,* having short funiculus segments, short palps and an upright scale. It is also one of the few *Cataglyphis* species that does not tilt the gaster upward when foraging. The partially alate queen from Al Qatif appears similar to the workers in all structural essentials but is differently coloured, not being evenly dark brownish black.

Al Qatif queen: TL 7.5; HL 1.63; HW 1.45; SL 1.35; hind femur 1.80; maxillary palp segment no. 3 0.38; no. 4 0.25; nos. 5 + 6 0.29; funiculus segment no. 1 0.3; no. 2 0.15.

Dorsum of gaster, a patch on the propodeum, the whole mesonotal dorsum, the petiole and irregular areas of the head shining brown, the rest including the appendages, reddish. All surfaces including the scapes and tibiae with scattered long hairs. The whole body is shining but the mesonotum is quite heavily sculptured at the sides; the gaster is brilliant as in the worker.

***Cataglyphis isis*** Pisarski, 1967 n. stat. (fig. 78)

*Cataglyphis bicolor* ssp. *diehli* var. *isis* Forel, 1909; Bull. Soc. vaud. Sci. nat. *45:* 385.

*Cataglyphis diehli* (ssp.) *isis* Pisarski, 1967: 421.

W. Tobuk IV.79; ☿☿ KAU-NHMB expedition. Hair valley 17.IV.83; Hair desert 18.IV.83; ☿☿ ♀ CAC.

This is a distinct species not related structurally to *C. bicolor* but to *C. diehli* having, like the latter, proportionately shorter funiculus segments and a shorter thinner petiole node. It differs from *C. diehli* in having a strongly pubescent alitrunk and occasional erect hairs on the antennal scapes and is clearly a distinct species. It is one of the smallest of the nodal *Cataglyphis* group. The largest workers do not exceed 9.5 mm in length. The queen is likewise small and slender, HW 1.88 mm, compared with that of *C. niger,* HW 2.62 mm.

The known distribution of *C. isis* is centred on the Suez region – Egypt, Sinai but Pisarski 1967, has recorded it from Afghanistan and the records from the Central Region of Saudi Arabia also represent a considerable extension of its range.

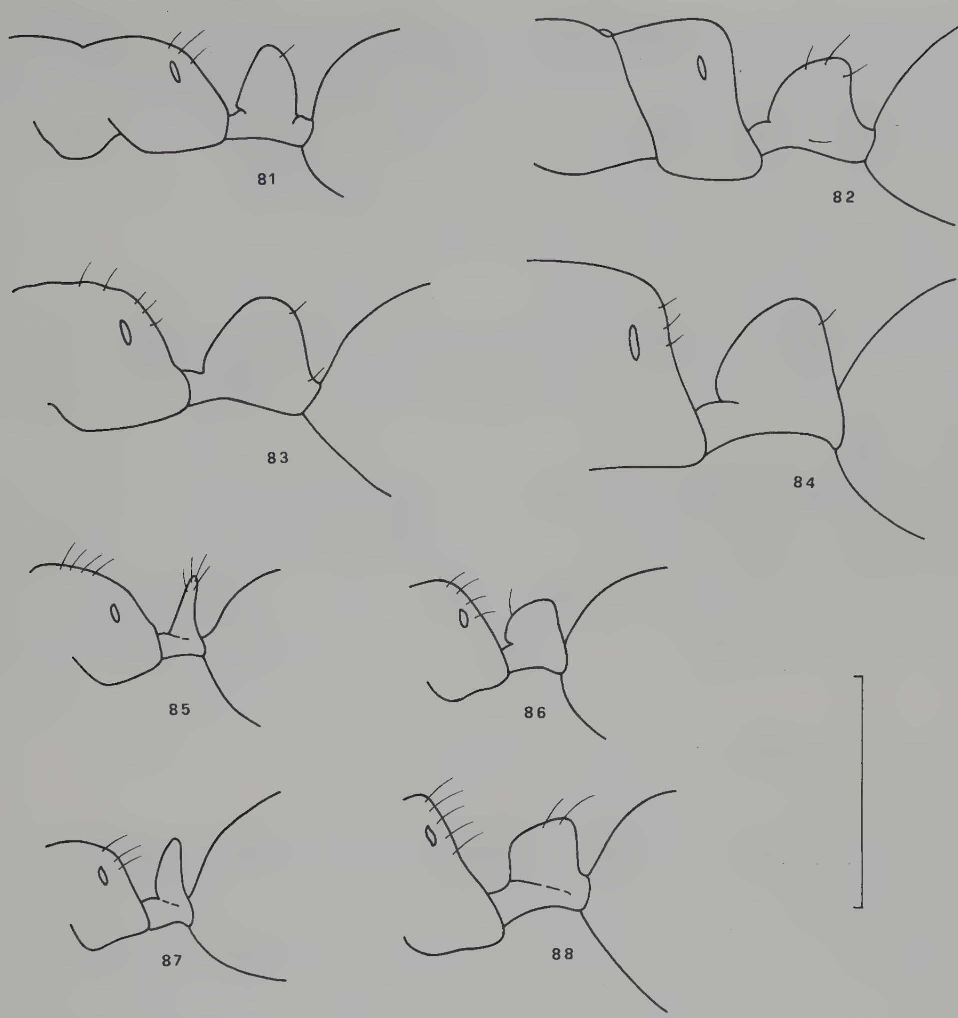
***Cataglyphis laevior*** Stitz, 1916 n. stat. (fig. 81)

*Cataglyphis bicolor* var. *laevior* Stitz, 1916; Mitt. zool. Mus. Berl. *8:* 348.

*Cataglyphis bicolor* st. *laevior.* – Santschi, 1929: 47.

Jeddah 6.V.78; Riyadh 28.VIII.75; ☿☿ W. Büttiker. Abu Arish resthouse environs 3.IV.83; Al Tawlah 7.IV.83; ☿☿ CAC.

This is a brightly coloured species with the clear red head and alitrunk contrasting with the brilliant unsculptured dark gaster. The workers have short funiculus segments and a high short node as in *C. diehli* and *C. laevior* is clearly a distinct species unrelated to *C. bicolor.*




Figs 81–88: Petiole profile of *Cataglyphis*. 81, *C. laevior* ☿; 82, *C. urens* ☿; 83, *C. desertorum* ☿; 84, *C. niger* ☿; 85, *C. sabulosa* ☿; 86, *C. livida* ☿; 87, *C. emmae* ☿; 88, *C. semitonsa* ☿. (Scale bar 1 mm).

***Cataglyphis minima*** n. sp. (fig. 75)

Bishah 7.IV.83; desert west of Najran 10.IV.83; ☿☿ ♀ CAC.

This is a very small black species closely similar to *C. albicans*.

Holotype large worker: TL 4.4; HL 0.93; HW 1.08; SL 1.15; length of hind femur 1.45; hind tibia 1.35; CI 105.4; SI 106.5.

Paratype small worker: TL 3.62; HL 0.78; HW 0.80; SL 1.02; length of hind femur 1.32; hind tibia 0.90.

Body colour entirely shining black, appendages yellow. Pubescence very sparse; surface of dorsum smooth and shining almost without sculpture except superficially on mesonotum and propodeum. Maxillary palp segment 4 not longer than 5 + 6. The petiole dorsum is more rounded than in *C. albicans*. Dorsal hairs on the alitrunk are few or none. The workers are very like those of *C. albicans* but are less sculptured with minimal pubescence and have fewer body and appendage hairs. Worker size is within the lower limits of the *C. albicans* range: *C. albicans* TL 3.75–8.0; mean 5.87. *C. minima* TL 3.63–4.50, mean 4.06. The mean relative length of hind femur to head is 1.46; in Arabian *C. albicans* it is 1.34.

Paratype queen: TL 7.5; HL 1.56; HW 1.62; CI 104.

Colour dark reddish black; appendages paler. Whole dorsum and antennal scapes with some long hairs. Petiole is thin in profile. The queen is about 2 mm shorter than that of an average *C. albicans.*

Holotype and paratypes in NHMB.

***Cataglyphis livida*** (André, 1881) (fig. 86)

*Myrmecocystus albicans* var. *livida* André, 1881; Annls. Soc. ent. Fr. *6,* 1: 58.
*Cataglyphis albicans* ssp. *livida* (André) Emery, 1925: 262.
*Cataglyphis livida.* – Pisarski, 1967: 467.

Khaybar 26.IV.79; Wadi Jureisi 30.IV.80; Sah al Rimah 24.IV.80; Al Fresh 28.IV.80; Hofuf 30.I.80; Riyadh 31.IX.80; Bani Musayqirah 16.IX.81; Shoiba 2.IX.83; Addar 28.I.83; ☿☿ ♀♀ W. Büttiker. Riyadh 22.III.83; desert west of Najran 10.IV.83; Al Qatif 15.IV.83; Hair valley 17.IV.83; Hair desert 18.IV.83; ☿☿ ♀♀ CAC.

Most of these samples have the head with only the most superficial sculpture near the occipital corners and correspond to the Arabian form of this species *C. albicans* subsp. *livida* var. *arabica* Emery, 1906. This was described from Aden. The Middle East and Afghanistan form of this species was given subspecies rank by Pisarski (1967) (*Cataglyphis livida lutea* Emery). This has a slightly more sculptured head than the Arabian samples but there is insufficient information at present to show whether these forms are minor variants of a species complex or worth distinguishing as subspecies or even species.

***Cataglyphis niger*** (André, 1882) n. stat. (figs 80, 84)

*Myrmecocystus viaticus* var. *niger* André, 1882; Spec. Hym. Europe *2:* 167.
*Cataglyphis bicolor* st. *nigra* (André) Santschi, 1929: 50.

Riyadh 15.I.80; ☿ W. Büttiker. Riyadh 22.III.83; Al Kharj public park 23.III.83; Al Kharj desert 23.III.83; Zahran 25.III.83; Shaqiq 8.IV.83; Hofuf sand mountain 13.IV.83; Al Qatif sandy desert 16.IV.83; ♂ ☿☿ ♀♀ CAC.

This was the most conspicuous and probably largest of the *Cataglyphis* species, the big workers having heads up to 3 mm wide and reaching 12.5 mm in total length. It is abundant in the Middle East and is also recorded from Tunisia. A form of this species with a slightly smaller node and more finely sculptured moderately shining gaster was taken at Abu Arish 2.IV.83; Al Tawlah 7.IV.83; Wadi Shugub 7.IV.83 and Hair desert 18.IV.83. This may be the same as *C. caerulescens* Santschi (Tohmé 1969: 14) but the original description is too imprecise to establish its status with respect to *C. niger.*

***Cataglyphis nodus*** (Brullé, 1832)

*Formica nodus* Brullé, 1832; Exped. Sc. Moree Zool. *2:* 32.

There is an old record for this bicoloured South East European species from Riyadh but no specimens that could properly be assigned to *C. nodus* were seen during the present study.

***Cataglyphis urens*** n. sp. (fig. 82)

*Cataglyphis bicolor* st. *abyssinica* v. *urens* Santschi, 1929: 52.

Wadi Shugub Turabah 6.IV.80; ☿☿ W. Büttiker. Wadi Dawasir desert 24.III.83; Al Kharfah desert 24.III.83; Hofuf tamarisk park 13.IV.83; Sulaiel desert 11.IV.83; Hair desert 18.IV.83; ☿☿ CAC. Oman: Mugsin Dhofar 20.IX.79; ☿ R.P.Whitcombe.

This species has large bright coloured workers which were seen actively foraging in open sandy desert. According to the only previous record and type locality, Muscat, this is a truly endemic species. Santschi 1929, linked *C. urens* to *C. abyssinica* through the relatively low node but the remarkably high raised propodeum clearly distinguishes it as a distinct species.

Typical large worker: TL 12.5; HL 2.80; HW 2.65; SL 3.20; CI 94.5; SI 121; Propodeum height to length 1.48 : 1.13, ratio 131; Petiole height to length 0.80 : 1.13, ratio 141. Hind tibial length 4.63. (Petiole and propodeal ratios for an equivalent sized *C. nodus* are 105 and 100 respectively.)

Head, alitrunk and petiole clear red, gaster brown; all appendages pale reddish brown. Hind tibia with mainly decumbent to subdecumbent fine hairs on extensor surface but with some erect hairs at the uppermost fifth. (*C. nodus* has only very sparse short completely decumbent hairs on the extensor surface.).

In a brief and inadequate description SANTSCHI (1929) gives the following characters (my translation): legs not darker than aliltrunk, sides of gaster shining, dorsum of head and propodeum with some erect hairs, anterodorsal edge of mesonotum projecting. All these fit *C. urens* but they are rather variable characters.

However the cotype from Muscat is clearly the same as the numerous samples from Saudi Arabia and Oman all having the characteristic high propodeum contrasting with the low node. A taxon named *Myrmecocystus bicolor* var. *congolensis* Stitz, 1916: 337, said to be widespread in Sudan and Senegal, may well prove to be the same as *C. urens* but according to SANTSCHI (1929) erect body hairs are absent from the dorsum of the alitrunk whereas these are present in all *C. urens* samples.

***Cataglyphis rubra*** (Forel, 1903)

*Myrmecocystus albicans* ssp. *rubra* Forel, 1903; Annls. Soc. ent. Belg. *47:* 268.
*Cataglyphis albicans* ssp. *ruber* (Forel) Emery, 1912; Zool. Jb. Suppl. *15* (1): 99.

Oman: Montasar 15.IX.84; ☿ M. Gallagher. Mugshin Dhofar 25.IX.79; ☿☿ R.P. Whitcombe.

This ant has the whole of the alitrunk and node shining yellowish red, the basal gaster tergite testaceous and the rest of the gaster shining brown; the legs and antennae are entirely yellowish red. Erect hairs are absent from the dorsum of the alitrunk except for an occasional hair on the propodeum or node. Colour, pilosity and the very sparse pubescence separate this species from the black *C. albicans* and from the somewhat similar but entirely yellow *C. livida. C. rubra* is recorded from deserts to the south of the Atlas mountains. This species also occurs in Tunisia in semi desert country.

***Cataglyphis sabulosa*** Kugler, 1981 (fig. 85)

*Cataglyphis sabulosa* Kugler, 1981; Israel J. Ent. *15:* 84.

Al Kharfa desert 24.III.83; Al Qatif sandy desert 16.IV.83; ☿☿ ♀♀ CAC. Oman: Mugshin Dhofar 20.VII.79; ☿ R.P. Whitcombe.

This is an interesting species allied to *C. bombycina* (Roger) but without a differentiated "soldier" caste. It was described from Southern Palestine and Sinai. The pale yellow workers do not raise the gaster when foraging but flit rapidly over the sand like pale ghosts and are very hard to catch.

***Cataglyphis saharae*** Santschi, 1929 n. stat. (fig. 79)

*Cataglyphis bicolor* st. *saharae* Santschi, 1929; Revue suisse Zool. *56:* 48.

Wadi Khumra 10.II.78; ☿☿ W. Büttiker. Al Kharfa 24.III.83; Al Tawlah 7.IV.83; Hair valley 17.IV.83; ☿☿ CAC.

Workers assigned to this species have the gaster shining as in *C. laevior* but differ by the longer funiculus segments, the wider node and more sculptured head.

***Cataglyphis semitonsa*** Santschi, 1926 (fig. 88)

*Cataglyphis albicans* var. *semitonsa* Santschi, 1926; Bull. Soc. Hist. nat. Afr. N. *17:* 236.
*Cataglyphis semitonsa.* – Tohmé, 1969: 14.

Zahran 25.III.83; Al Kola 10.IV.83; ☿☿ CAC.

Workers of this species were taken singly and no nest was seen. They not only differ in colour from *C. albicans* but also in sculpture having both head and alitrunk distinctly sculptured and duller. The mean ratio hind femur length to head width based on five workers is 1.63 compared with *C. albicans* from Arabia, 1.34. Hitherto this species has been recorded from North Africa and the Lebanon.

## Genus *Acantholepis* Mayr

| List of species: | Geographical distribution: |
|---|---|
| *Acantholepis arabica* n. sp. | Endemic |
| *Acantholepis canescens* Emery, 1897 | North east Africa |
| *Acantholepis carbonaria* Forel, 1892 | North east Africa |
| *Acantholepis depilis* Emery, 1897 | North east Africa |
| *Acantholepis dolabellae* Forel, 1911 | Middle East |
| *Acantholepis erythraea* Forel, 1910 | North east Africa |
| *Acantholepis frauenfeldi* (Mayr, 1855) | North Africa, South east Europe |
| *Acantholepis gracilicornis* Forel, 1892 | Middle East, Arabia |
| *Acantholepis incisa* Forel, 1913 | East and Central Africa |
| *Acantholepis longinoda* Arnold, 1920 | South Africa |
| *Acantholepis nigrescens* Karawajew, 1912 | North Africa |
| *Acantholepis obtusa* Emery, 1901 | North Africa |
| *Acantholepis opaciventris* Finzi,1930 | Middle East |
| *Acantholepis simplex* Forel, 1892 | East Africa, North India |
| *Acantholepis spinnisquama* Kuznetsov-Ugamskij, 1929 | Turkestan, Afghanistan |

These are small black or bicoloured ants, active in full daylight and usually found in the neighbourhood of trees or shrubs over which they forage for scale or aphid honeydew and for insect prey. They are numerous around waterways and in river valleys subject to flooding and are often dominant in such places. Most species are polygynous. The queens are much larger than the workers and are usually much more pubescent, generally lack their propodeal armature but have incised or emarginate petioles corresponding with those of their particular workers. Males are small and black; their 12 segmented antennae have elongate scapes and funiculus segments.

### Key to species

| | | |
|---|---|---|
| 1. | Antennal scape twice as long as head width, overreaching occiput by two thirds its length; SI 190–200 . . . . . . . . . . | 2 |
| – | Antennal scape less than twice as long as head width, overreaching occiput by half its length or less; SI 110–175 . . . . . . . . . . | 4 |
| 2.(1) | Head and alitrunk clear red **longinoda** Arnold | |
| – | Whole body uniformly black . . . . . . . . . . | 3 |
| 3.(2) | Gaster and propodeum with superficial sculpture **opaciventris** Finzi | |
| – | Gaster and propodeum brilliant **gracilicornis** Forel | |
| 4.(1) | Antennal scape 1.5 or more x HW, SI 150–175, overreaching occiput by about half its length . . . . . . . . . . | 5 |

– Antennal scape only slightly longer than HW, SI 110–128, overreaching occiput by a third or less of its length ........ 9
5.(4) Alitrunk entirely pale red; whole dorsum clothed with blunt black setae ***arabica*** n.sp.
– Alitrunk partly red or entirely black; dorsum with scattered fine pale hairs mainly on pronotum ........ 6
6.(5) Petiole scale narrowly rounded with shallow incision ***nigrescens*** Karawajew
– Petiole acutely dentate ........ 7
7.(6) Propodeal processes produced into long thin curved spines more than x 0.75 their intervening width ***spinnisquama*** Kuznetsov-Ugamskij
– Propodeal processes dentate with teeth about x 0.5 or less their intervening width ... 8
8.(7) Bicoloured species with head and gaster dark contrasting with red alitrunk ***dolabellae*** Forel
– Alitrunk black or with mesonotum only partly red ***frauenfeldi*** (Mayr)
9.(4) Head and gaster smooth and brilliant ........ 10
– Head and gaster sculptured ........ 11
10.(9) Whole dorsum thickly clothed with pale hairs ***canescens*** Emery
– Alitrunk without dorsal hairs ***simplex*** Forel
11.(9) Whole dorsum with scattered erect pale hairs ***obtusa*** Emery
– Dorsal hairs on alitrunk sparse, mainly restricted to pronotum or nil ........ 12
12.(11) Petiole angles produced into long spines ........ 13
– Petiole emarginate or dentate at most ........ 14
13.(12) Petiole spines longer than their intervening width ***incisa*** Forel
– Petiole spines about as long as half their intervening width ***carbonaria*** Forel
14.(12) Petiole dentate; coarse dorsal sculpture especially on propodeum not obscuring cuticular shine; one or two occasional pronotal hairs ***depilis*** Emery
– Petiole rounded with very shallow emargination; whole body finely sculptured and dull; alitrunk entirely without dorsal hairs ***erythraea*** Forel

***Acantholepis arabica*** n. sp. (fig. 89)

Al Tawlah 7.IV.83; 5 ☿☿ CAC.

This is a handsome red species characterised by numerous short black body hairs. Unfortunately its presence in the field was not recognised among the abundant *Monomorium venustum* and *Tetramorium sericeiventre* of similar size and colouring so that only five workers were collected.

Holotype worker: TL 3.5; HL 0.83; HW 0.70; SL 1.05; alitrunk length 1.00; SI 150; CI 84.3.

Head and alitrunk clear pale red; gaster dark with basal face of first tergite testaceous. Tarsi, distal half of scape and antennal club brown; rest of appendages pale red. Head shining, micsopropodeum sculptured, gaster brilliant. Short black hairs are scattered all over the body; in dorsal view occipital hairs extend round genae to eye level. Scapes and tibiae have short oblique pubescent hairs. The head is oval with rounded sides and a straight occipital border. The pronotum is flattened medially. The propodeal spines are long and curved; the petiole spines are very long.

This elegant species resembles *Acantholepis longinoda* Arnold of South Africa in colour and body shape including long propodeal and petiole spines but differs in pilosity, the body hairs of *A. longinoda* being few, fine and pale.

Holotype and paratype ☿☿ in NHMB; paratype ☿ in BMNH.

***Acantholepis canescens*** Emery, 1897

*Acantholepis capensis* ssp. *canescens* Emery, 1897; Annali Mus. civ. Stor. nat. Giacomo Doria *38:* 601.
*Acantholepis canescens.* – Bernard & Cagniant, 1962; Bull. Soc. ent. Fr. *67:* 163.

Najran 24.III.83; Zahran 25.III.83; Sug al Ahad 26.III.83; Fayfa hillside 28.III.83; Fayfa 29.III.83; Al Tawlah 7.IV.83; Wadi Shugub 7.IV.83; Shaqiq 8.IV.83; Tanuma 8.IV.83; Riyadh 19.IV.83; ☿☿ ♀ CAC.

This was one of the most abundant species of the genus seen. It is small, black and shining with widely spaced broad propodeal teeth and a moderately indented petiole. The whole body is clothed with stiff pale hairs. It differs from *A. capensis* Mayr by its smaller size, finer pilosity and absence of propodeal sculpture.

***Acantholepis carbonaria*** Forel, 1892

*Acantholepis carbonaria* Forel, 1892; Annls. Soc. ent. Belg. *36:* 41.

Al Qahman mangrove swamp 1.IV.83; Sug al Ahad riverside 26.III.83; ☿☿ CAC.

This small species is distinguished by its dull black appearance and long petiole spines.

***Acantholepis depilis*** Emery, 1897 n. stat.

*Acantholepis capensis* ssp. *depilis* Emery, 1897; Annali Mus. civ. Stor. nat. Giacomo Doria *38:* 602.

Badr Hanayn 18.IV.79; KAU-NHMB ☿; Wadi Hamaniyah 31.III.80; Shoiba 18.IX.83; ☿☿ W. Büttiker. Bishah 7.IV.83; Al Tawlah 7.IV.83; ☿☿ ♀ CAC.

Erect hairs on the alitrunk of this black sculptured species are restricted to a very few on the pronotum and are often absent. Despite the coarse sculpture especially on the propodeum, the underlying cuticular shine is not obscured. The sparse pilosity differentiates this species from *A. capensis.*

***Acantholepis dolabellae*** Forel, 1911 n. stat. (fig. 93)

*Acantholepis frauenfeldi* ssp. *dolabellae* Forel, 1911; Bull. Soc. vaud. Sci. nat. *47:* 351.

Araida, Selouly's Farm 5.IX.75; 1 ☿ W. Büttiker.

This single worker is the sole representative of this common Middle East species. The alitrunk is red and the head slightly darker, both contrasting with the dark gaster. Apart from colour, this species differs from *A. frauenfeldi* by the finely sculptured alitrunk.

***Acantholepis erythraea*** Forel, 1910 n. stat. (figs 90, 91)

*Acantholepis carbonaria* var. *erythraea* Forel, 1910; Zool. Jb. Abt. Syst. *29:* 265.

Desert west of Najran 10.IV.83; ☿☿ CAC.

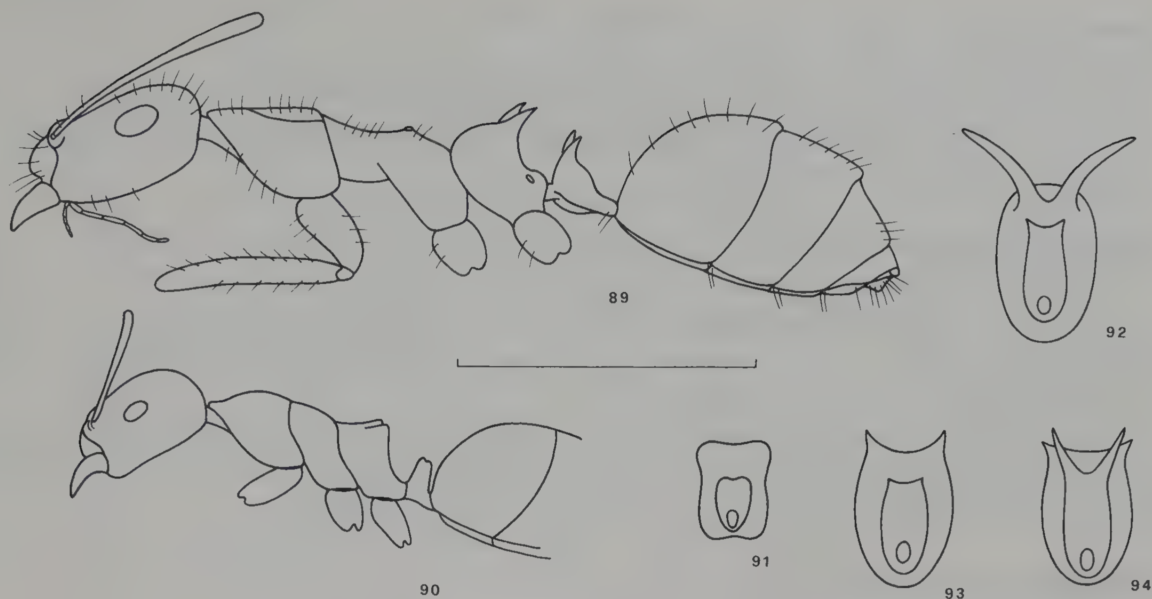
These small opaque dark workers have no hairs on the dorsum of the alitrunk, very reduced propodeal prominences and a petiole scale that is only very slightly indented with rounded corners. *A. erythraea* in the Geneva collection is similar in size, pilosity and colour but the propodeal armature is slightly more prominent. *A. carbonaria* of which this was described as a variety, cannot be the same species since it has the propodeum distinctly dentate and the petiole bispinose.

***Acantholepis longinoda*** Arnold, 1920

*Acantholepis longinoda* Arnold, 1920; Ann. S. Afr. Mus. *14:* 555.

Oman: Wahiba sands 7.XII.84; ☿☿ M. Gallagher.

This species was described from South central Africa and Oman representing a considerable extension of its known range. It is an elegant clear red species with exceptionally long appendages, SI 200.




Figs 89, 90: Profile view of *Acantholepis*. 89, *A. arabica* ☿; 90, *A. erythraea* ☿. Figs 91–94: Petiole and propodeum in posterior view. 91, *Acantholepis erythraea* ☿; 92, *A. spinnisquama* ☿; 93, *A. dolabellae* ☿; 94, *A. incisa* ☿. (Scale bar 1 mm).

***Acantholepis frauenfeldi*** (Mayr, 1855)

*Hypoclinea frauenfeldi* Mayr, 1855; Verh. zool.-bot. Ges. Wien *5:* 378.

*Acantholepis frauenfeldi* (Mayr) Mayr, 1861; Europ. Formic.: 42.

Hair valley 17.IV.83; ☿☿ CAC.

This was the only place where this common South east European and North African species was found.

***Acantholepis gracilicornis*** Forel, 1892

*Acantholepis gracilicornis* Forel, 1892; Annls. Soc. ent. Belg. *36:* 42.

Fayfa hillside 29.III.83; Fayfa cultivated valley 30.III.83; Al Qahman mangrove swamp 1.IV.83; ☿☿ CAC.

This species was described from Aden in South Arabia. It is characterised by its very long appendages, long thin alitrunk and brilliantly shining integument.

***Acantholepis incisa*** Forel, 1913 n. stat. (fig. 94)

*Acantholepis capensis* ssp. *incisa* Forel, 1913; Revue zool. afr. *2:* 338.

Anamas 8.IV.83; ☿☿ ♀ CAC. The petiole spines in this species are very long and the workers with these exaggerated structures are clearly specifically distinct from the much more shining, simply dentate *A. capensis*.

***Acantholepis nigrescens*** Karawajew, 1912 n. stat.

*Acantholepis frauenfeldi* var. *nigrescens* Karawajew, 1912; Russk. ent. Obozr. *12:* 15.

Wadi Khumra 10.II.78; Taif 11.IV.79; Quawayiyah 7.IV.78; Al Hunayy 20.X.78; Thanomah 11.IV.80; ☿☿ W. Büttiker. Sulaiel desert 14.IV.83; Hair desert 17.IV.83; ☿☿ CAC. Yemen: Amlah XI.79; ☿ Barri & Poggesi (B. Lanza).

This shining black species is similar to *A. frauenfeldi* but has the petiole with reduced teeth, the antennal scapes longer and the pronotum more convex. It was described from North Africa.

**Acantholepis obtusa** Emery, 1901 n. stat.

*Acantholepis carbonaria* var. *obtusa* Emery, 1901; Bull. Soc. ent. ital. *33:* 63.

Abu Arish 25.III.83; Al Qatif coastal beach 15.IV.83; ☿☿ CAC.

This is a small dull opaque species, clearly differing from *A. carbonaria* in the relatively abundant dorsal pilosity and simply dentate petiole.

**Acantholepis opaciventris** Finzi, 1930

*Acantholepis opaciventris* Finzi, 1930; Sber. Akad. Wiss. Wien, math.-naturw. Kl. *139:* 23.

Wadi Shuwas 9.IV.80; Wadi Fayidah 10.X.83; Shoiba 15.X.83; ☿☿ W. Büttiker. Sug al Ahad 26.III.83; Fayfa 27.III.83; Karm Rauish 5.IV.83; Al Tawlah 7.IV.83; Wadi Shugub 7.IV.83; Al Kola 10.IV.83; Hair desert 17.IV.83; ☿☿ ♀♀ CAC.

This is similar to *A. gracilicornis* in the long appendages but differs in sculpture. The propodeum and gaster are faintly sculptured with a dull shine instead of being completely brilliant. It appears to be one of the commoner Saudi Arabian species, forming large polygynous colonies.

**Acantholepis simplex** Forel, 1892

*Acantholepis simplex* Forel, 1892; Annls. Soc. ent. Belg. *36:* 43.

Jeddah 7.IV.78; ☿☿ W. Büttiker. Fayfa cultivated valley 30.III.83; Wadi Shugub 7.IV.83; Riyadh Agricultural Centre 19.IV.83; ☿☿ CAC.

This is a small species similar to *A. canescens* but entirely without hairs on the alitrunk. This species was described from North east Africa but has a wide range through Africa and is recorded also from West and North India according to Bingham (1903).

**Acantholepis spinnisquama** Kuznetsov-Ugamskij, 1929 (fig. 92)

*Acantholepis frauenfeldi* ssp. *spinnisquama* Kuznetsov-Ugamskij, 1929; Zool. Anz. *82:* 480.

*Acantholepis spinnisquama.* – Pisarski, 1967: 410.

Socotra: Adho Dimellus IV.76; ☿ K.M. Guichard. Oman: Batina 16.II.78; ☿ R.P. Whitcombe. Dhofar 13.II.84; ☿☿ M. Gallagher.

This species has workers whose propodeal processes are extended into long curved spines. It is brilliantly shining as in *A. gracilicornis* but has proportionately shorter appendages and more extended armature both of the propodeum and of the petiole. The only specimens in NHMB that compared with the Arabian material were found under the name of *A. spinnisquama.* This species was described from Turkestan but has also been recorded from Afghanistan (Pisarski 1967).

## Genus **Plagiolepis** Mayr

| List of species: | Geographical distribution: |
|---|---|
| *Plagiolepis abyssinica* Forel, 1894 | North East Africa |
| *Plagiolepis maura* Santschi, 1920 | North Africa |
| *Plagiolepis pygmaea* (Latreille, 1798) | South Europe |
| *Plagiolepis schmitzii* Forel, 1895 | North Africa, South West Europa |
| *Plagiolepis tumidula* Emery, 1915 | North West Africa |

These are minute to small species, 1.15–2.5 mm long, although the genus does include some larger forms. They are mostly soil dwellers but some also live in rotten wood. The Arabian species were not found in the open desert but in mountain areas, decaying trees or in leaf litter.

## Key to species

1. Dorsal outline of alitrunk not interrupted by raised metanotum. Eyes prominent set forward. Scale upright. First funiculus segment shorter than combined second to fourth **tumidula** Emery
– Dorsal outline of alitrunk visibly interrupted by raised metanotum. Eyes set about middle of head. Scale an inclined node overhung by gaster. First funiculus segment as long as combined second to fourth. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

2.(1) Size very small < 1.3 mm body and appendages completely pale yellowish brown; eye length one sixth of head length **abyssinica** Forel
– Size larger > 1.5 mm. Colour pale brown to dark brown; eye length two fifths or more of head length. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

3.(2) Second and third funiculus segments subequal, broader than long and each much shorter than fourth **pygmaea** (Latreille)
– Third funiculus segment about twice or more length of second. . . . . . . . . . . . . . . . . . 4

4.(3) Third and fourth funiculus segments subequal longer than broad. Pubescence on appendages prominent; on gaster mean interface is shorter than length of hair. Total length 2.0 mm or more. Colour brown **schmitzii** Forel
– Third funiculus segment quadrate shorter than fourth. Pubescence sparse; on gaster mean interspace about same as length of hair. Total length less than 2.0 mm. Colour pale brown **maura** Santschi

***Plagiolepis abyssinica*** Forel, 1894 n. stat. (fig. 95)

*Plagiolepis exigua* ssp. *abyssinica* Forel, 1894; Mitt. schweiz. ent. Ges. *9:* 73.

Fayfa 30.III.83; ☿☿ CAC.

These were taken from a roadside tree nesting in partially rotten wood. *P. abyssinica* is slightly larger, TL 1.25, and darker than the oriental *P. exigua* Forel, TL 1.12. Other measurements from a typical worker are HL 0.35; HW 0.28; SL 0.28; CI 80; SI 100; EL 0.05. (x 0.18 HW).

***Plagiolepis maura*** Santschi, 1920 (fig. 98)

*Plagiolepis maura* Santschi, 1920; Bull. Soc. vaud. Sci. nat. *53:* 169.

Abu Arish 25.III.83; Al Kola 10.IV.83; Riyadh Agricultural Centre 19.IV.83; ☿☿ CAC.

This is a small yellowish brown species differing from *P. schmitzii* by the shorter funiculus segment 3, smaller size, sparser pubescence and generally pale colour. Measurements from a typical worker are HL 0.45; HW 0.40; SL 0.40; EL 0.14; CI 89; SI 100; TL 1.62. This species was taken variously in soil litter.

***Plagiolepis schmitzii*** Forel, 1895 (fig. 97)

*Plagiolepis pygmaea* var. *schmitzii* Forel, 1895; Mitt. schweiz. ent. Ges. *10:* 5.

*Plagiolepis schmitzii*. – Santschi, 1920; Bull. Soc. vaud. Sci. nat. *53:* 168.

Anamas 8.IV.83; Tanuma 8.IV.83; ☿☿ ♀♀ CAC.

This species is common in South west Europe and occurs widely in North Africa. It was found in the Asir mountains nesting under stones in a different kind of habitat to *P. maura*. The antennal scapes and funiculus segments are relatively longer than in that species. Measurements from a typical worker are HL 0.50; HW 0.45; SL 0.49; CI 90; SI 108; TL 2.0. Gaster pubescence is closer than in *P. maura* and the queens have prominent pubescence on the appendages.

***Plagiolepis pygmaea*** (Latreille, 1798)

*Formica pygmaea* Latreille, 1798; Essai Fourmis Fr.: 45.

*Plagiolepis pygmaea* (Latreille) Mayr, 1861; Europ. Formicid.: 43.

There is an old determination for this species for Jebel Musmah at an altitude of 2700 m leg. H. Scott & E.B. Sutton, 1930. This South European species is not known to occur in North Africa or the Middle East but has been found as far south as the Maltese Islands.

***Plagiolepis tumidula*** Emery, 1915 (fig. 96)

*Plagiolepis (Tapinolepis) tumidula* Emery, 1915; Boll. Soc. Labor. Zool. Scu. Agric. Portici *10:* 19.

Najran 10.IV.83; ☿☿ CAC.

Individual workers were seen but were very fugitive and disappeared rapidly into the sandy ground at the slightest disturbance. No colony was found and two workers only of this minute, large eyed species could be secured from leaf litter on sandy soil under a shrub. Measurements from one of the workers are HL 0.38; HW 0.35; SL 0.38; EL 0.12; CI 93.3; SI 107; eye length almost one third head length; TL 1.4. The species was described from North east Africa. The two examples meet Emery's description only partially, being smaller and this identification must be regarded as tentative.

## Genus *Anoplolepis* Santschi

***Anoplolepis*** sp. indet. (fig. 99)

Sug al Ahad bare soil in sandy track 26.III.83; 2 ☿☿; Riyadh Agricultural Centre 18.IV.83; 1 ☿ CAC.

These three workers could not be determined to species. The antennae are eleven segmented with the first funiculus segment nearly equal to the second plus third. All funiculus segments are elongate and the scape over-reaches the occiput by about the length of the first funiculus segment. The hind tarsi are long, the tarsal segments together longer than either the tibia or the femur. The propodeal spiracle is large and prominent. The petiole is an upright scale. The alitrunk is flat in profile but the outline is broken by the shallow metanotal furrow. The maxillary palps are longer than the head. The body colour is uniformly brown with the legs somewhat paler. Both the body and the appendages are clothed with short adpressed pubescence.

TL 2.35; HL 0.65; HW 0.55; SL 0.60; EL 0.23; PW 0.39; Hind femur 0.85; Hind tibia 0.86; Hind tarsus 1.00.

## Genus *Paratrechina* Motschulsky

Only two widely distributed cosmopolitan species were found.

### Key to species

1 Body dark brownish black. Antennal scapes long reaching as far back as the metanotal suture. Body hairs long but sparse on the alitrunk ***longicornis*** (Latreille)

– Body yellowish with apex of gaster dark. Antennal scapes not extending far beyond occipital border. Body hairs profuse on alitrunk and crowded on the gaster ***jaegerskjoeldi*** Mayr

### *Paratrechina jaegerskjoeldi* (Mayr, 1901)

*Prenolepis jaegerskjoeldi* Mayr, 1901; Res. Swed. Exp. White Nile *9:* 8.

*Paratrechina jaegerskjoeldi* (Mayr) Emery, 1925: 218.

Hofuf 7.V.78; 9.V.78; 13.V.78; 19.V.78; Riyadh 28.I.78; Khaybar 26.IV.79; Wadi Shuwas 9.IV.80; Jeddah XII.83; ♂♂ ♀♀ ☿☿ W. Büttiker. Riyadh 22.III.83; Al Qatif 14.IV.83; ♂♂ ♀♀ ☿☿ CAC. Oman ☿☿ R.P. Whitcombe, M. Gallagher.

This species is locally very abundant and has become a household pest in many places. Nests are in rotten wood, in the irrigated pathways of parks and gardens or in the footings of buidlings. It occurs in Egypt and throughout the Middle East.

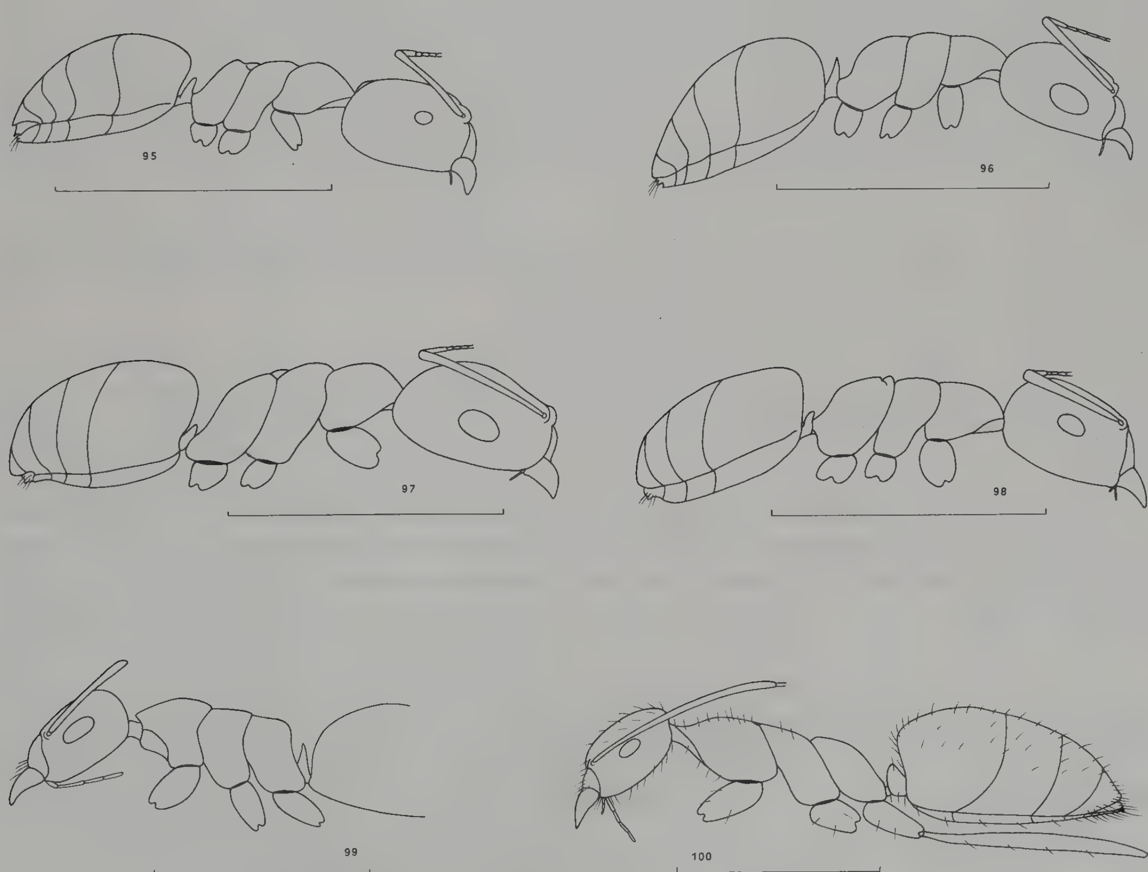
### *Paratrechina longicornis* (Latreille, 1802) (fig. 100)

*Formica longicornis* Latreille, 1802; Fourmis: 113.

*Paratrechina longicornis* (Latreille) Emery, 1925: 217.

Jeddah 1.V.80; Harithi 22.I.84; NW of Tobuk 24.IV.79; ☿☿ W. Büttiker. Fayfa 27.III.83; Al Kola 10.IV.83; desert west of Najran 10.IV.83; ♀♀ ☿☿ CAC. Oman ☿☿ R.P. Whitcombe, M. Gallagher.

This has a worldwide distribution and is as abundant in Asia as in Africa. It moves very rapidly over the ground and can easily be mistaken for an *Acantholepis* species. Nests are under stones and colonies are less populous than with *P. jaegerskjoeldi.*




Figs 95–100: Profile view. 95, *Plagiolepis abyssinica* ☿; 96, *P. tumidula* ☿; 97, *P. schmitzii* ☿; 98, *P. maura* ☿; 99, *Anoplolepis* sp. ☿; 100, *Paratrechina longicornis* ☿. (Scale bar 1 mm).

## DISCUSSION

The breakdown of the geographical distribution of the present known Arabian fauna gives the following in approximate percentages: Endemic 11; Cosmopolitan 6; Indian 4; South European 7; Tropical African 12; North east and North African 39; Middle East and Oriental 21.

The larger part of the ant fauna therefore is more of an extension of that of Africa than of the Middle East. Most of the afrotropical species were found, as might be expected, in the sheltered valleys on the Yemen border in the far southwest around Fayfa and Abu Arish. These include *Anochoetus tragaeordhi, Pachycondyla ambigua, Platythyrea modesta, Messor galla, Pheidole sculpturata, Crematogaster luctans, C. senegalensis, Melissotarsus emeryi, Tetramorium khyarum* and *Polyrhachis viscosa.*

Species with their main distribution in the Middle East are comparatively few. They include *Belonopelta loebli, Messor ebeninus, M. meridionalis, M. orientalis, M. semirufus, Tetramorium syriacum, Monomorium abeillei, M. karawajewi, Cataglyphis niger, C. livida, C. sabulosa, Acantholepis dolabellae, A. opaciventris.*

The main habitat groups may be categorised as follows: Arboreal – species that are only found on or in trees or branches – *Tetraponera* spp., *Melissotarsus emeryi, Leptothorax angulatus, Cardiocondyla wroughtonii, Crematogaster aegyptiaca, C. affabilis, C. acaciae, C. chiarinii, C. luctans, Technomyrmex* sp., *Plagiolepis abyssinica, Camponotus ilgii, C. fayfaensis.* Deserticolous – species that are only or mainly found in open sandy desert with sparse vegetation – *Messor striaticeps, M. syriacus, Crematogaster antaris, Monomorium afrum, Tetramorium juba, Cataglyphis abyssinica, C. livida, C. rubra, C. desertorum, C. minima, C. diehli, C. saharae, C. urens, Acantholepis erythraea.* Here environmental conditions are at their most extreme with surface soil temperatures around midday in the hotter months of the year around 50 °C or more (CLOUDESLY-THOMPSON 1962) and the preponderance of the long legged, desert adapted *Cataglyphis* ants is marked.

Litter – species that are only or mainly found in leafy debris – *Belonopelta loebli, Hypoponera* spp. *Pachycondyla ambigua, Cardiocondyla emeryi, Pheidole minuscula, Tetramorium caldarium, T. jizani, T. simillimum, Plagiolepis tumidula.* This is perhaps the most profitable habitat type to search for the more uncommon cryptic species. These should include Dacetini species which are still unrecorded from the Arabian fauna.

Mountain and highland pasture – *Messor aralocaspius, M. minor, M. rufotestaceus, Tetramorium depressiceps, Monomorium zulu, Camponotus alii, C.atlantis, C.flavomarginatus, C.empedocles, Cataglyphis asiriensis, C.semitonsa, Acantholepis arabica, Plagiolepis schmitzii, Technomyrmex setosus.*

Most species however occur over a wide range of habitat including savannah type landscape, river valleys, rough pasture and semi-cultivated areas. These include the majority of species in the genera *Messor, Pheidole, Monomorium, Tetramorium, Camponotus* and *Acantholepis,* constituting over 60% of all species recorded.

Cosmopolitan or tramp species include a number of small species spread by trade from one country to another. Some of these have the status of minor pests in domestic or public buildings. Such species include *Hypoponera punctatissima, Pheidole megacephala, Monomorium destructor, M. gracillimum. M. pharaonis, Cardiocondyla emeryi, C. nuda, Tetramorium caldarium, T. simillimum, Triglyphothrix lanuginosa, Tapinoma melanocephalum.*

Endemic specis include the following first records: *Cerapachys wittmeri, Messor buettikeri, Tetramorium jizani, Camponotus arabicus, C. fayfaensis, C. jizani, Cataglyphis asiriensis, C. minima, Acantholepis arabica* and *Technomyrmex setosus.* Others described by Emery, Forel or Santschi include *Monomorium luteum, Tetramorium calidum, Cataglyphis adenensis, C. urens* and *Camponotus adenensis.* However many of these supposed endemics may well occur in similar habitats in other territories especially in the still under-recorded North east Africa. Previous records for the whole of Arabian territory include only seventeen species compared with the present total of 164 so there is evidently scope for much further collecting in adjacent territories as well as Arabia.

Ants must play an important part in the regulation of other arthropod populations since in Arabia as in other Middle East and subtropical countries, they occur often in considerable numbers in every type of habitat visited and at every site. However many carnivorous species including *Cataglyphis* are scavangers rather than direct predators with exceptions among the Ponerinae, Dorylinae and a few Myrmicine species. They are also probably an important source of food for insectivorous birds especially during mating flights when large numbers will be eaten by such birds as swifts and swallows.

## ACKNOWLEDGEMENTS

I am most grateful to Dr. W. Wittmer for suggesting a collecting trip to Saudi Arabia and for providing necessary funds from Pro Entomologica, Basel and to Mr. Abdul Aziz el Mudbil, Deputy Minister for Agriculture, for sponsoring the visit. I am also grateful to Prof. A.S. Talhouk for making all necessary arrangements including the provision of accommodation, transport and suggestions for the routes to be followed. Essential assistance was provided by Messrs Sarko Tilkian and Radhi Abozuhairah of the Regional Agriculture and Water Research Entomology Division who drove my coleopterist colleague Mr. C. Holzschuh and myself many thousands of kilometres often through very difficult terrain to the various collecting sites.

I am very grateful for facilities afforded me for studying comparative material to Dr. Claude Besuchet of the Muséum d'Histoire Naturelle, Geneva; to Dr. Michael Brancucci and Dr. Cesare Baroni Urbani of the Naturhistorisches Museum Basel; to Mr. Barry Bolton of the British Museum (Natural History) London, who also helped with ponerine identifications and made considerable and necessary corrections to the text with respect to the formal treatment of nomenclature and to literature references; and to Prof. Jehoshua Kugler who provided representative species from the Middle East. My thanks go to Dr. E.J.M. Evesham for copying my drawings to a standard acceptable for publication and finally to Prof. W. Büttiker for ant collections made over a wider area than I was able to travel and for supplying colour photographs of representative landscapes.

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# Oasis Fishes of Eastern Saudi Arabia

W. Ross

Abstract: The oasis fishes of Eastern Saudi Arabia listed here consist of one secondary freshwater species, ten marine species found in drainage systems and seven introduced species. The fish listed were collected from seven oases, three coastal and four inland oases.

Keywords: Eastern Saudi Arabia, secondary freshwater fishes, marine fishes, exotic fishes, oases.

أسماك الواحات الشرقية من المملكة العربية السعودية

و . روس

خلاصة : تتألف أسماك الواحات الشرقية من المملكة العربية السعودية المذكورة في هذا البحث من نوع ثانوي يعيش في المياه العذبة وعشرة أنواع بحرية تعيش في المصارف المائية وسبعة انواع مدخلة . ولقد تم جمع هذه العينات من سبعة واحات : ثلاثة منها ساحلية وأربعة داخلية .

## INTRODUCTION

From September 1977 until May 1981 I collected many marine fish from the waters of the coastal oases in the eastern Province of Saudi Arabia. These specimens were collected alive from water with a salinity of up to 5 ppt, and were maintained in aquaria with water of a salinity of 1.2 ppt. Figs 2 to 10 accompanying this paper are of these fish, most of them were returned to the wild.

Early in 1979, I started collecting notes on introduced species of freshwater fish found in the oases, this has continued up until the time of writing. Many of the photographs are of living specimens obtained from the oases, the other photos are of preserved specimens.

I propose to describe the fish under three headings: 1. Secondary freshwater fish. 2. Marine fish found in the oases. 3. Introduced species. No primary freshwater fish are known from eastern Saudi Arabia (Krupp 1983).

### Geography

Geographically the area covered by this paper, ranges from Al-Aba in the North to Hofuf in the south (see fig. 1). Three of the oases are coastal, four are inland; three of the inland oases have no outlets to the sea, but Hofuf, the most inland of all, has a seasonal outlet to the Arabian Gulf. All wells investigated supporting the oases are artesian.

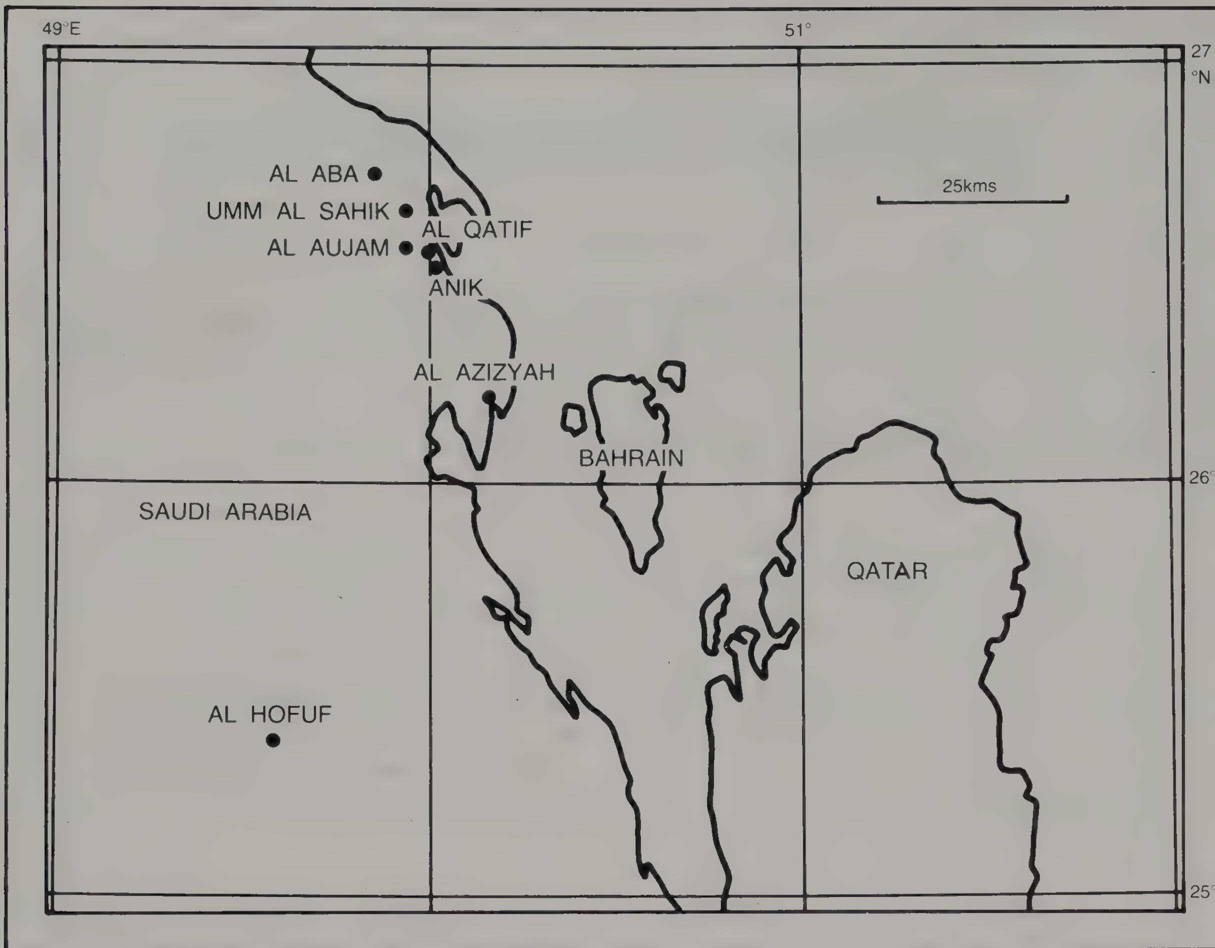


Fig. 1: Map of the oases of eastern Saudi Arabia.

### Coastal oases

Al-Qatif, the largest of the coastal oases (plate 1). Consider it divided into north and south at the Taroot causeway. It is heavily populated, and of late, sewage disposal into the drainage ditches has caused a deterioration in the flora and fauna.

Anik, south of Al-Qatif. Another fairly heavily populated oasis, it has also suffered from sewage disposal, especially the main drainage ditch originating at the village of Al-Jesh. This ditch however appears to be improving at the time of writing.

Al-Azizyah (plate 2); prior to 1981 this was one of the most fruitful oases as far as fish collecting was concerned. Mullet, snappers and killifish were plentiful in the two small drainage ditches entering the Gulf. Unfortunately, the well supplying the water to this drainage area has been closed; the walls of the well collapsed, sealing the well. There is no longer enough surplus drainage water to maintain these two sea connections.

### Inland oases

Al-Aba, the most northerly oasis discussed (plate 3). Although partially cultivated this oasis is uninhabited. Surplus water runs to waste, creating fairly extensive reed beds, with no evidence of introduced fish and an abundance of naturally occurring killifish *(Aphanius dispar)*, Caspian terrapins *(Mauremys caspica)* and marsh frogs *(Rana ridibunda)*.

Plate 1: Al-Qatif drainage ditch.

Plate 2: Al-Azizyah drainage ditch.

Plate 3: Well at Al-Aba.

Umm Al-Sahik, slightly further south than the previous oasis. Another fairly heavily populated area with an apparent building boom in and around it. No evidence of introduced fish. *A. dispar* is to be found throughout the irrigation system.

Al-Aujam, situated almost directly inland from Al-Qatif. Many old-style wells still exist at the rear of the oasis, close to the Safwa-Abu Hadriyah highway interconnecting road. Apparently there are plans to extend the agricultural area of this oasis.

Hofuf (Al-Hassa), the most southerly oasis discussed. Although the most distant from the sea, this oasis has a seasonal connection with the Arabian Gulf. During the cool season, the main drainage ditch empties into Halfmoon Bay. In summer, stretches of this ditch dry out, leaving many expanses of landlocked water. Al-Hassa is the largest oasis in the eastern Province; it consists of many villages with extensive agricultural areas. Its many natural springs have been cemented in, and fitted with sluice gates to facilitate the collection and distribution of the water. There are reputed to be 1,624 km of concrete irrigation channels and 1,520 km of earth ditches to lead away drainage water (GOELLNER 1975); all of this is controlled by the Al-Hassa Irrigation and Drainage Authority.

## MATERIALS

Fishes collected from the wild by the author, maintained in brackish water aquaria, and released into the wild when they had outgrown the author's facilities. A photographic colour slide collection of these is maintained by the author.

Specimens sent to the British Museum (Natural History); *Aphanius dispar* were transferred as living specimens. Marine and freshwater fishes were preserved in formalin until delivered to the British Museum (Natural History).

Meristic characters:

A: number of anal fin rays; Roman numerals refer to unbranched rays, Arabic numerals refer to branched rays; in Cyprinodontidae the total number of fin rays is given.

D: number of dorsal fin rays (counted as stated under A).

GR: total number of gill rakers.

LL: number of scales in the lateral line.

Other abbreviations:

BMNH: British Museum (Natural History).

APC: Author's photographic collection.

## SECONDARY FRESHWATER FISH

### Fam. **Cyprinodontidae**

*Aphanius* is the only genus of secondary freshwater fish so far described from Arabia (KRUPP 1983, ALKAHEM & BEHNKE 1983).

***Aphanius dispar*** (Rüpell, 1828)

*Lebias dispar* Rüppell, 1828. – Atlas zu der Reise im nördlichen Afrika: 66 (Red Sea).

Material: BMNH 4,(1)1981·10·6·1,(2)1981·10·6·283–284,(1) no number.

Plate 4: *Aphanius dispar* male from Al-Qatif.

Plate 5: *Aphanius dispar* female from Al-Qatif.

Plate 6: *Lutjanus argentimaculatus* from Al-Azizyah (photo P. W. Stroud).

Widely distributed between NE Africa and NW India, living under freshwater, brackish or marine conditions. D: 8–11, A: 9–11, LL: 24–28, GR: (11) 14–16(17). Grow to 80 mm. The mouth is superior. There are 12–20 tricuspid teeth per jaw. Scales are large and well-developed, those around the least circumference of the caudal peduncle number 16 in almost all specimens. Gill rakers are large, slightly curved and widely spaced. There are 11–17 (modally 13–16) gill rakers on the anterior side of the first gill arch. Sexual dimorphism is expressed in the length of the fins and colour pattern. Preserved males are brownish with scales having a darker margin. On the flanks and above all in the caudal peduncle there are light whitish blotches and transverse or irregular bars. The caudal fin contains 2–3 broad dark transverse bars. There are irregular stripes in the dorsal fin and the posterior third of the caudal fin. In adult males the dorsal fin may be extremely long and reach beyond the base of the caudal fin (see plate 4). Preserved females are brownish-grey. There are 8–20 narrow transverse bars on the flanks. Fins are light grey and transparent (plate 5). The anal fin may be much longer in males than in females. Ross (1980) describes colour variations of this fish.

*A. dispar* is to be found in most of the oases where open water occurs. They are to be found at Ain al-Abd, the inland oasis close to the Saudi/Kuwait border (Relyea 1981). They were introduced successfully to the Al-Kharg area in 1948, this was done to help with the control of anopheline mosquito larva (Daggy 1959).

Many *A. dispar* collected are infested with metacercaria larvae (Ross 1979).

## MARINE FISH FOUND IN THE OASES

White & Barwani (1971) were used extensively in the marine fish identification.

### Fam. **Chanidae**

***Chanos chanos*** (Forsskål, 1775)

*Mugil chanos* Forsskål, 1775. – Descript. Animal.: XIV, 74 (Jeddah).

Material: APC.

Found only in tropical Africa and Asia. D: 14–16, A: 8–10, LL: 75–91. Can grow to 180 cm but those usually caught are about 100 cm. For body shape, see fig. 2. Large grooved scales. Greenish grey on top, rest of fish silver. Although superficially herring-like in appearance, the milkfish is only distantly related. It differs from the herrings by the rearward placing of the pelvic fins, by the four branchiostegal rays each side beneath the throat, and by the possession of a lateral line. Often in shoals in shallow areas. North Al-Qatif drainage ditches were the haunts of this fish in 1979/80.

### Fam. **Hemirhamphidae**

***Hemirhamphus marginatus*** (Forsskål, 1775)

*Esox marginatus* Forsskål, 1775. – Descript. Animal.: XIII, 67 (Jeddah, Red Sea).

Material: APC.

Throughout the Arabian Gulf, Africa and Japan. D: 13–14, A: 10–13. Caudal deeply forked with lower lobe elongated as seen in fig. 3. Lower jaw elongate with no teeth on section past upper jaw, tip of lower jaw coloured red in life. Length 45 cm. Very common in estuaries, inlets and close to shore-

lines. Large shoals of these, approximately 8–10 cm in length were to be found in the main drainage ditch north of Al-Qatif.

### Fam. **Theraponidae**

One member of this family, small relatives of the sea bass and groupers, is to be found in the waters of the coastal oases.

***Therapon jarbua*** (Forsskål, 1775)

*Sciaena jarbua* Forsskål, 1775. – Descript. Animal.: XII, 50 (Jeddah, Suez).

Material: APC

South Arabian Gulf; Indo-Pacific excluding Hawaii. D: XI–XII/10, A: III/8, LL: 76–99, GR: 13–14. Dorsal and anal spines very sharp. Caudal forked, body shape as in fig. 4. Spines on preopercle. Length 25 cm. When young these fish will shoal but as they mature they become solitary. Known to spawn in estuaries. Young specimens were collected in the estuaries at Al-Qatif and Al-Azizyah.

### Fam. **Lutjanidae**

***Lutjanus argentimaculatus*** (Forsskål, 1775)

*Sciaena argentimaculata,* Forsskål, 1775. – Descript. Animal.: XI, 47–48 (Red Sea).

Material: APC.

Widespread in the tropical Indo-Pacific, and found from the Red Sea and E African coast to N Australia and west Pacific islands. D: X/13–14, A: III/8–9, LL: 44–56, GR: 9–12. Length 90 cm. See plate 6 for body shape. This is one of the few snappers which lives in fresh water. Collected at Al-Qatif and Al-Azizyah. At Al-Qatif, some of them had penetrated the interior waters of the oasis where they settled in some of the pools; it was noticeable that *A. dispar* were less numerous in these pools, possible cause being predation by *L. argentimaculatus.*

### Fam. **Sparidae**

Three members of the bream family inhabit the drainage ditches of Al-Qatif and Anik. Two of these have been identified but the third one remains unidentified. This fish had a typical bream shaped body with a forked caudal as seen in fig. 5. Two specimens collected from Al-Qatif were prone to jumping out of the water when excited, unfortunately they died as a result of doing this from their aquarium during my absence and were not preserved.

***Acanthopagrus berda*** (Forsskål, 1775)

*Sparus berda* Forsskål, 1775. – Descript. Animal.: XI, 32–33 (Lohaja).

Material: APC.

An Indo-Pacific species found from the Red Sea and East African coast of India, the E Indies and N Australia. D: XI/11–12, A: III/8–9, the second anal spine is large and well developed. LL: 43–46, GR: 9–11. Size 28–40 cm. Typical high compressed body terminating in a forked caudal as seen in fig. 6. It is a common species in inshore waters, around wharfs, on reefs, and in sandy bays. It is also found in estuaries (Wheeler 1975). In April 1979 a 15 cm specimen was collected in the main drainage ditch,

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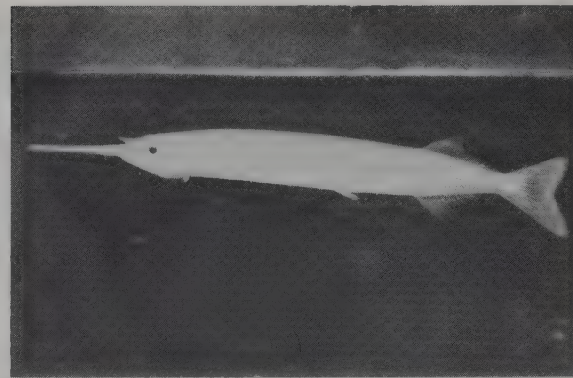

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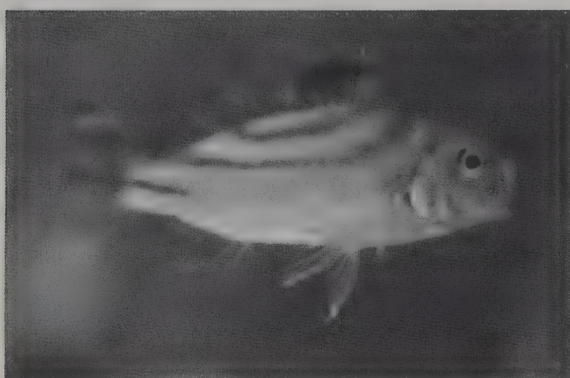

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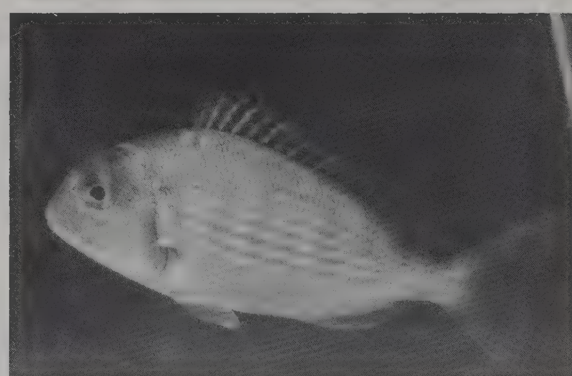

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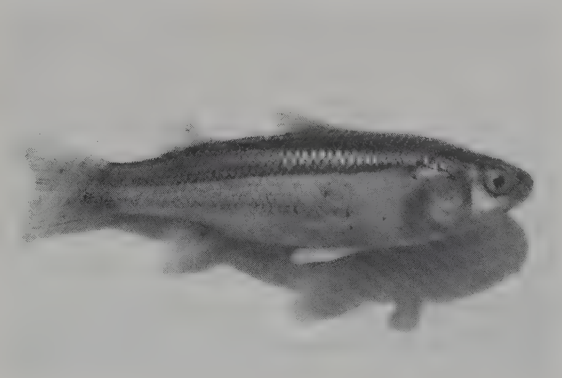

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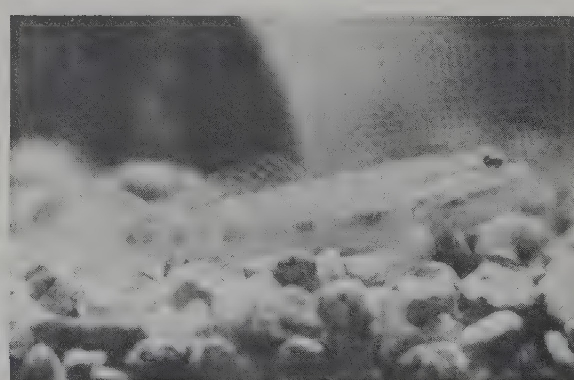

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north Al-Qatif. At that time these fish were common at Al-Qatif and at Anik, where many large specimens were observed. Many small specimens were collected at south Al-Qatif in July 1979. Often found in same habitat as *Rhabdosargus sarba.*

***Rhabdosargus sarba*** (Forsskål, 1775)

*Sparus sarba* Forsskål, 1775. – Descript. Animal.: XI, 31 (Jeddah).

Material: APC

Widespread in both the Indian and Pacific Oceans, found from the Red Sea and East African coast, around India, the East Indies, north Australia, and north to Japan. D: XI/13–14, A: III/11–12, LL: 62–65. Forked caudal see fig. 7. All the anal hard rays are of a similar size unlike *A. berda,* but body shape similar. Young specimens may be found in the drainage system south Al-Qatif during the months June and July.

## Fam. **Mugilidae**

Erdman (1950) recorded mugilids from Al-Hassa, without giving a scientific name.

***Mugil cephalus*** Linnaeus, 1758

*Mugil cephalus Linnaeus, 1758.* – Syst. Nat., ed. X: 316 ("Ocean Europaeo").

Material: BMNH, 3 specimens.

A very widely distributed mullet which is found in the tropical and temperate waters of the world, both in the open sea and inshore waters, estuaries and almost freshwater (Wheeler 1975). Appears to spend most of its life in rivers and creeks, returning to the sea to spawn.

D: IV,I/8, A: III/8, LL: 38–42. Length 50 cm. A streamlined body with two dorsal fins (fig. 8). Like other mullets it is usually found in small shoals. These fish were plentiful in the main drainage ditch from Al-Hassa. It feeds on diatoms, algae, and minute animal material found amongst the bottom mud. The feeding habits of tilapiine fishes are similar, it gives rise to concern at the fate of the Al-Hassa mullet, now that *Oreochromis* are established in the same waters.

## Fam. **Gobiidae**

Gobies are a diverse group of fishes found in all seas, and occasionally in fresh water, from shallow shorelines to deeper waters, and in a variety of habitats ranging from mud flats to coral reefs (Relyea 1981).

***Bathygobius fuscus*** (Rüppell, 1828)

*Gobius fuscus* Rüppell, 1828. – Atlas zu der Reise im nördlichen Afrika: 137 (Red Sea).

Material: BMNH, 2 specimens.

Throughout Arabian Gulf; Indo-Pacific. D: VI,I/8–9, A: I/8–9, LL: 38–40. Round body with largish blunt head, see fig. 9. A drab coloured goby. Collected in a tidal-influenced drainage ditch at the south end of Al-Qatif oasis. These fish are solitary and territorial, generally living in holes or under stones.

Figs 2–9: 2, *Chanos chanos* from Al-Qatif; 3, *Hemirhamphus marginatus* from Al-Qatif; 4, *Therapon jarbua* from Al-Qatif (photo P. W. Stroud); 5, Unidentified bream from Al-Qatif (photo P. W. Stroud); 6, *Acanthopagrus berda* from Al-Qatif (photo P. W. Stroud); 7, *Rhabdosargus sarba* from Al-Qatif; 8, *Mugil cephalus* from Hofuf main drainage ditch; 9, *Bathygobius fuscus* from Al-Qatif.

### Fam. **Soleidae**

A large family of right-handed flatfish.

***Synaptura orientalis*** (Bloch & Schneider, 1801)

*Pleuronectes orientalis* Bloch & Schneider, 1801. – Blochii Syst. Ichthyol.: 157.

Material: APC.

Throughout Arabian Gulf; Indo-Pacific. D: 65, A: 53. Dorsal, anal and caudal fins all run into one another, see fig. 10. Size range 12–30 cm. Found on soft sand stratum in the lower reaches of a ditch south Al-Qatif. Not very common, only one specimen collected.

## INTRODUCED SPECIES

### Fam. **Poeciliidae**

A large family of small fishes found naturally in the Americas, from the south U.S., through Central America, and South America as far south as Argentina. Several species are particularly good destroyers of larval mosquitos, and thus of direct importance as controllers of disease caused by insect larvae (WHEELER 1975). Some species are very popular aquarium fish. The ability of some to destroy mosquito larvae, and the beauty of others as aquarium fish, has resulted in Poeciliidae being spread worldwide. It is not really surprising that four species of this fish are now established in eastern Saudi Arabia.

***Gambusia affinis holbrooki*** Girard, 1859

*Gambusia holbrookii* Girard, 1859. – Proc. Acad. nat. Sci. Philadelphia *11:* 61.

Material: BMNH, 3 ♂♂, 1 ♀.

This fish has been distributed throughout the warm, temperate and tropical zones of the world, as a controller of the larvae of malaria-carrying mosquitos. Natural distribution: Along the east and south states of the U.S., from New Jersey to Texas and south to north Mexico.

Males grow to around 3.5 cm, see fig. 11 for body shape. Females grow larger, 6 cm and resemble female *Poecilia reticulata*. Sexual differences: size, shape and male gonopodium.

Established throughout the Al-Hassa oases.

***Poecilia latipinna*** (Lesueur, 1821)

*Mollinesia latipinna* Lesueur, 1821. – J. Acad. Sci. Philadelphia *2* (1): 3.

Material: BMNH 1984·5·9·66–75, 14 males.

Natural distribution: east states of America from Carolina to Yucaton, in coastal regions and near the mouths of rivers.

D: 13–14, grows to around 9 cm. The chief characteristic of this species is the beautiful dorsal fin of the male, this is iridescent blue, higher than the body of the fish, it extends the full length of the body from immediately behind the gill covers. In comparison, the female is dull coloured and has a comparatively short dorsal fin (fig. 12).

Early in 1979 a few black *P. latipinna* were observed in two drainage ditches, one at Anik and the other south of Al-Qatif. In 1983 three colour variations of *P. latipinna* were collected at Anik: original

wild-coloured fish, speckled fish, and black fish similar to the cultured specimens sold in the local aquarium shops. These black fish are very noticeable in the ditches.

***Poecilia reticulata*** Peters, 1859

*Poecilia reticulata* Peters, 1859. – Monatsber. Akad. Wiss. Berlin (1859): 412.

Material: APC.

Natural distribution: North Brazil, the Guyanas, Venezuela, Barbados, and Trinidad. It has also been introduced to many tropical regions as a controller of the larval stages of malaria-carrying mosquitos. The rather large range of this little fish has resulted in considerable variation both in body form and colouration. In the wild, males grow to around 3 cm, females larger at 6 cm (fig. 13).

The Anik drainage ditches have a large population of *P. reticulata.* As often happens with domesticated species returned to the wild, they are reverting to their original colours and fin shapes. There is evidence of this species at Al-Hassa, see discussion.

***Xiphophorus maculatus*** (Günther, 1866)

*Platypoecilus maculatus,* Günther, 1866. – Cat. Fish. Br. Mus. *6:* 350.

Material: APC.

Natural distribution: Central America, southern Mexico, Guatemala and northern Honduras.

D: 10–12, A: first rays modified to form a gonopodium. See fig. 14 for body shape. Size: 6 cm.

A small colony of these fish is established in a large drainage ditch south of Al-Qatif. Not so easily found as the other introduced species.

## Fam. **Cichlidae**

Indentification of tilapiine fishes is in accordance with Trewavas (1983). They occur in rivers that drain into the Atlantic, and in the Great Rift Lakes of East Africa. They occur northward into the Nile delta, and southward to South Africa (Goldstein 1973). Tilapiinae have been used extensively in fish culture as a food fish, they have been introduced to many waters throughout the tropics for this purpose. Three species of *Oreochromis* are established in the Al-Hassa irrigation and drainage system.

***Oreochromis aureus*** (Steindachner, 1864)

*Chromis aureus* Steindachner, 1864. – Verh. zool. bot. Ges. Wien *14:* 229, pl. 8, fig. 5 (West Africa).

Material: BMNH 1984·9·7·77–78, 2 specimens.

Natural distribution: West Africa, Egypt, Palestine and Jordan.

D: XVI/12, A: III/8, GR: 18–26 on lower part of arch. Size: 40 cm. Body shape as fig. 15. Very similar to *O. niloticus* but differs in that the caudal fin never bears the regular dark vertical stripes of *O. niloticus* but has a broad pink to red distal margin. Specimen collected from Al-Hassa main drainage ditch.

***Oreochromis mossambicus*** (Peters, 1852)

*Chromis (Tilapia) mossambicus* Peters, 1852. – Ber. Akad. Wiss. Berlin (1852): 681 (Mozambique).

Material: BMNH, 1 male.

Natural distribution: East Africa, south to the Zambezi River and Port Alfred in South Africa.

D: XV–XVI/10–13, A: III/9–12, LL: 31, GR: 16–19. Caudal truncate see fig. 16. Shape: large head with lower jaw enlarged in mature males, thickset deep body. Very long dorsal fin, covering nearly the whole of the back.


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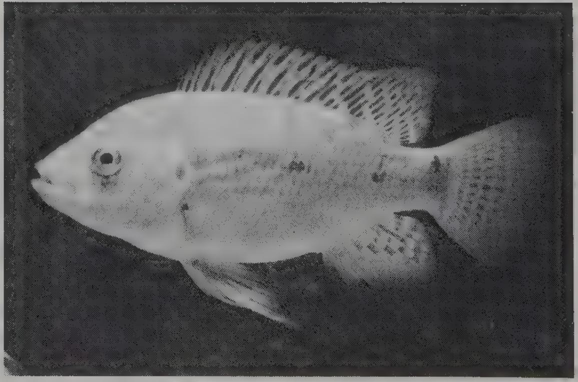
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Specimens collected from the wells and main irrigation channel at Al-Hassa. Not as numerous as *O. niloticus*.

***Oreochromis niloticus*** (Linnaeus, 1758)

*Labrus niloticus* Linnaeus, 1758. – Syst. Nat., ed. X: 286.

Material: BMNH 1984·9·7·75–76, 2 specimens; BMNH 1984·9·7·79–80, 2 specimens.

Natural distribution: Widespread in Africa, found from East Africa across to the Congo and Nigeria, Egypt and Palestine.

D: XVII/12–14, A: III/9, LL: 31–33, GR: 20–26 on lower part of the first arch. Body shape as fig. 17. This is one of the larger cichlid species, and specimens of up to 6 kg have been reported. Its food is mainly plankton, but this species is very adaptable and it also eats insects and crustaceans as well as blue-green algae (Wheeler 1975). It is for its algae eating habit that it was introduced to Al-Hassa.

Two specimens were collected from the main concrete irrigation channel, and examined by Dr. E. Trewavas (BMNH). These were found to have only 16 dorsal spines, modal number 17, however 16 is found occasionally and is modal in subspecies *vulcani*. One specimen collected from the main drainage ditch has slightly different characteristics. This fish had 17 dorsal fin spines, but the number of soft rays was rather low, 11. Phenotypes of hybrids might look like this. Although the number of specimens examined was low, it is possible there are two different populations of *O. niloticus* established at Al-Hassa. *O. niloticus ? vulcani* in the pre-irrigation water and *O. niloticus* in the drainage water, see discussion.

## DISCUSSION

Krupp (1983) initiated this paper. Although the geographical area covered is much smaller and has no primary freshwater fishes, it has numerous marine fish found in the drainage systems of the coastal oases, and many recently introduced species. To the six species of freshwater fish introduced to Arabia (Krupp 1983) this paper adds a further five. Furthermore to the two families of marine fish entering freshwater reported from Arabia (Krupp 1983) this paper adds another six families.

Extensive land reclamation in Taroot Bay has been responsible for the redirection of some of the drainage ditches, both of these factors plus oil pollution in the Gulf have had a detrimental effect on the marine fish. Most of the collecting from the coastel oases was done prior to 1981. Many species may no longer be found or are present in much reduced quantities.

Al-Aba oasis, with its abundance of flora and fauna, although small in acreage, would lend itself to being a mini national park. A small island oasis surrounded by sabkha.

Many of the livebearing toothcarps are prolific, even under aquarium conditions. Human nature being what it is, one can understand the reluctance of people to destroy a healthy living creature, which they have watched being born, then growing to maturity. The unfortunate outcome of this is the dumping of unwanted fish into local waters. It is noticeable that introduced species of fish are more often to be found in human inhabited oases.

Figs 10–17: 10, *Synaptura orientalis* from Al-Qatif (photo P. W. Stroud); 11, *Gambusia affinis holbrooki* male from Hofuf well; 12, pair *Poecilia latipinna,* male lower fish, from Anik; 13, *Poecilia reticulata* female from Anik drainage ditch; 14, *Xiphophorus maculatus* male from Al-Qatif; 15, *Oreochromis aureus* from Hofuf main drainage ditch; 16, *Orechromis mossambicus* from Hofuf well; 17, *Oreochromis niloticus* from Hofuf main drainage ditch.

The origin of the *G. a. holbrooki* established throughout the Al-Hassa oasis is a bit of a mystery. On good authority it has been assured that there has been no attempt to establish *Gambusia* at Al-Hassa for malaria control. *G. affinis* was imported from Egypt prior to 1950 and these fish were used to establish colonies in the Al-Qatif area and at Yabrin but there is no mention of Hofuf (Daggy 1959). *Gambusia* were apparently on sale to the aquarium hobby in 1977. I reside close to Al-Qatif, but as yet, I have found no evidence of Daggy's *Gambusia* there. Unfortunately I have been unable to visit Yabrin, and therefore have no information on fish population from that oasis.

The hypothesis is that *P. latipinna* found in Anik and Al-Qatif originated from aquarium stock as the black variety, then by indiscriminate breeding in the wild reverted to their original wild-coloured varieties (Ross 1984).

*P. reticulata*, the delta-tailed variety of this fish is on sale in the Eastern Province. Three males were collected at Hofuf, these guppies possibly came from a shoal but as yet I have been unable to locate them. The fish may be established in some areas of the oasis, if so, it is only a matter of time until they make their presence known. At the moment the Anik fish are still showing signs of their domesticity. Some males are more colourful than wild ones, the caudal fins on many are longer, some have extended upper or lower rays. These fish are smaller than their domestic counterparts.

In 1981, Dr. Mohammed Shahjahan Howlader, King Faisal University, Al-Hassa, was responsible for the introduction of tilipiine fishes to the wells and concrete irrigation channels of Al-Hassa. This was done at the request of the Al-Hassa Irrigation and Drainage Authority, who had been experiencing difficulty keeping the wells and channels clear of weeds and algae. A pilot scheme using *Oreochromis* had been very successful. Dr. Shahjahan obtained what was thought to be *Oreochromis niloticus* from Taiwan, these were delivered to Saudi Arabia via Dacca. After their release into the irrigation system, it became apparent that they were not all *O. niloticus*. On contacting his supplier, Dr. Shahjahan was informed that at the time of supplying his fish they had *O. mossambicus* on their establishment. It now appears that this shipment of fish had been a mixed population, and, or hybrids of the two mentioned species; if not, then someone else introduced *O. mossambicus*. There is an unconfirmed report of some tilapiine fishes being brought in from the Philippines.

Two fish culture centres have been established on the edges of the main drainage ditch leading from Hofuf. Both of these establishments culture tilapiine hybrids, *O. niloticus* × *O. aureus*. The stock of these establishments originated from the Fish Culture Project of the Saudi Arabian National Center for Science and Technology (SANCST), Riyadh. Amongst this stock I have observed some red cherry tilapia, *O. mossambicus* × *O. u. hornorum*. One of the establishments imported red cherry tilapia, *O. mossambicus* × *O. u. hornorum* from the U.S.A., this fish farm also has pure *O. niloticus* and pure *O. aureus*. No matter how careful they have been, some of their stock have escaped into the main drainage ditch. As yet I have not seen red cherry tilapia free in the wild.

Tilapiine hybridization in the wild from introduced species has occured, as shown in Daget & Moreau (1981); Elder, Garrod & Whitehead (1971). The Al-Hassa tilapiines have a mixed origin; the *O. niloticus* in the pre-irrigation water i. e. wells and concrete channels having derived from the fish introduced by Dr. Shahjahan, this could also be said for the possible accidental introduction of *O. mossambicus*.

The fish in the drainage water possibly derived from both the fish farms' stock, the first fish on both establishments being hybrids *O. niloticus* × *O. aureus*. The first escapees possibly originated from *O. niloticus* and *O. aureus* plus the red cherry tilapia and there is now a possibility that amongst the fish in the drainage ditch specimens of all these plus hybrids could be found. Although morphologically the Al-Hassa waters have produced *O. aureus*, *O. mossambicus*, *O. niloticus* and *O. niloticus* ? *vulcani* plus two speci-

mens which could be hybrids, it is doubtful whether any of their genes would stand the trial of polyacrylamide gel electrophoresis for purity of species.

Whilst researching the ability of *Oreochromis* to control algae and weed growth at Al-Hassa, Dr. Shahjahan also experimented with *Cyprinus carpio.* This fish may be released into the water system in the future. A mishap released a small number of *Labeo rohita* into the irrigation system and there is a possibility that these may become established.

Both, the increase in fish farming (there is at least one fish farm at Al-Qatif) and the continuing popularity of the aquarium hobby, will probably give rise to additional introduced species in the future.

## ACKNOWLEDGEMENTS

It gives me great pleasute to thank Mr. J. Chambers, British Museum (Natural History) for his help with the marine fishes, Poeciliidae and the *Aphanius dispar* and for reading the manuscript and making numerous useful suggestions.

I am indebted to the following lady and gentlemen for their kind help: Dr. E. Trewavas , British Museum (Natural History), London, for her help and advice on tilapiine fishes; Dr. Mohammed Shahjahan Howlader, King Faisal University, Al-Hassa, Saudi Arabia; Dr. G. R. Allen, Western Australian Museum; Mr. P. W. Stroud, Dhahran, Saudi Arabia, for his help and advice with the photography; Mr. J. Royle and Mr. Z. Mathew, British Aircraft Corp., Dhahran, Saudi Arabia, and last but not least, my wife, Irene, for her help and encouragement.

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# Amphibians of the Arabian Peninsula

**E. Balletto, M. A. Cherchi*, J. Gasperetti**

Abstract: The Arabian amphibian fauna is comprised of nine nominal Anuran species, six of which are endemic to the peninsula (*Bufo arabicus, Bufo hadramautinus, Bufo scorteccii, Bufo dhufarensis, Bufo tihamicus, Euphlyctis ehrenbergii*), and three of which occur in the Palaearctic region (*Bufo viridis, Hyla savignyi, Rana ridibunda*). The synonomy, taxonomy, sexual dimorphism, systematics, biological and morphological characters of these species and their tadpoles are reviewed. Some nomenclatural problems are discussed and lectotypes are designated, in order to settle some controversial cases. The zoogeographical origins and affinities of the Arabian amphibian fauna are discussed. The ecology and the need for amphibian conservation are reviewed.

Keywords: Arabia, amphibians, tadpoles, taxonomy, zoogeography, ecology, conservation.

برمائيات الجزيرة العربيــــة

ا• باليتو و م • أ • كركي و ج • جسبرتي

خلاصة : تشمل مجموعة بدوائيات المملكة العربية السعودية على ٩ انواع فقط ، ستة منها مستوطنة في شبه الجزيرة العربية (Bufo arabicus و Bufo hadramautinus و Bufo scorteccii و Bufo dhufarensis و Bufo tihamicus و Euphlyctis ehrenbergii) وثلاثة منها معروفة في مناطق أخرى (Bufo viridis , Hyla savignyi , Rana ridibunda) ، وكذلك تم مراجعة المميزات الشكلية والعظمية والبيولوجية لجميع هذه الأنواع بالاضافة الى مراحلهم اليرقية (أبو ذنيبة) • كما تم حل بعض المشاكل المتعلقة بتسمية هذه الأنواع مع اعطاء التسميات الحديثة من أجل تسوية بعض الحالات المختلف حولها • كما نوقش أصل والارتباطات الجغرافية الحيوانية لمجموعة برمائيات السعودية •

## CONTENTS



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***In memoriam**

The manuscript for this paper was completed on 3.7. 1958. On the 18th day of the same month, Prof. Maria Adelaide Cherchi died. She is sadly missed by all who knew her.

## INTRODUCTION

The first description of an Arabian amphibian was *Bufo arabicus* Heyden, 1827 from "Arabia Petraea" based on a specimen collected by E. Rüppell during his epic expedition to Sinai and Midyan, down the Red Sea to Jiddah and to Sudan and Abyssinia from 1822 to 1826. Nearly contemporary with Rüppell's voyage, W. F. Hemprich and C. G. Ehrenberg were travelling and collecting natural history specimens while barely eking out their livelihood over much the same route. They visited Jiddah in early 1825, and continued south to Al Qunfidah thence to Massaua where Hemprich died of "fever" in June of that year. Between Jiddah and Al Qunfidah is probably where they collected the type specimen of *Euphlyctis ehrenbergii* (PETERS 1863 b).

Since that time many travellers collected specimens of natural history, usually in the course of other work and other more pressing reasons for being in Arabia. It is a pleasure to note some of those people who contributed to zoological collections, specifically the Arabian amphibia:

Sir Richard Burton (1877 & 1878: Midyan), W.T. Blanford (1886: Muscat), G. Doria (1882: Yemen), A.S.G. Jayakar (1885–1891: Muscat), Oskar Neumann (1892: Aden), Josef Bornmüller (1893–1894: Oman), Col. J.W. Yerbury (1895: Aden), J. Anderson's collector with J.T. Bent expedition to Hadramawt (1896), A.B. Percival (1899: Sheik Othman), Arif Bey (1900: Mecca), J.W. Bury (1903: southern Arabia), B. Thomas (1931: Dhufar), H.StJ.B. Philby (1932–1937: Saudi Arabia), B.F. Haythornthwaite (1936: Aden), E.B. Britton and H. Scott (1938: Aden and Yemen for BMNH). Notwithstanding the voluntary efforts of so many collectors, the amphibian fauna of the Arabian Peninsula remained largely unknown. Less than 150 specimens of batrachians represented all that was known from a subcontinent with an area of about 3 million square kilometers.

In the 1950's more herpetological material was made available, starting with the early collections of J. Gasperetti (1947: eastern Arabia), and later by G. Popov (1950–1953: Hadramawt), and R.S. Mathews (1955: eastern Arabia). The most notable expeditions to southwest Arabia pertinent to the amphibia were those of Prof. G. Scortecci in 1962 to the Hadramawt and in 1965 to Yemen. The first trip yielded more than 90% of the herpetological specimens ever collected in this part of the peninsula, and together with specimens collected during his trip to Yemen in 1965 provided the material for the description of three new amphibian taxa.

The rapid economic development of the Kingdom of Saudi Arabia and adjoining countries during the past few decades, and the growing interest of the authorities concerned with scientific research and conservation, resulted in the commencement of systematic faunal surveys (see BÜTTIKER 1979, 1981, 1983). Many of the amphibians that are the subject of this paper were collected as a result of these surveys.

The present work was devoted to the study and the description of the amphibians known from the Arabian peninsula based mainly on the field work outlined above. Tadpoles are described for species for which they were available provided there was reasonable certainty that they actually belonged to the identified species. It is not impossible, even when the adult and tadpole were found together, that by chance, they may have been of different species. This possibility may be ruled out in cases where the same tadpoles were found more than once together with the same species. Prof. G. Scortecci was particularly careful in this respect. He collected a large number of larvae, of which the level of certainty is sufficient. Cases of uncertainty are noted in the text.

The tadpoles of *Bufo hadramautinus* Cherchi are yet unknown. Also unknown are the tadpoles of the peninsula populations of *Hyla savignyi, Bufo viridis* and *Rana ridibunda.* For the latter two species, characters of tadpoles from populations outside the peninsula are provided in the identification key. For *Hyla savignyi,* the tadpoles of which were never described, the key ends at family level.

Ecological features of Arabian species are outlined. For more general characteristics of the Arabian peninsula refer to Büttiker (1979) and Krupp (1983). Additional information concerning collecting sites in Yemen and Wadi Hadramawt are described by Scortecci (1963, 1966a, 1966b).

The distribution maps for each species of the Anura are correlated to the sections titled "Other material". Where possible, we have given a map number or designation, the place name, geodetic coordinates and elevation, museum registry number, other data (if any), collector(s) initials and date of collection. If the specimen(s) had been previously reported, the author and date of publication is shown in brackets. Specimens noted in the literature but not seen by us are denoted by footnote ([5]).

## List of abbreviations

Abbreviations of institutions:

| | |
|---|---|
| BM(NH): | British Museum (Natural History). |
| CAS: | California Academy of Sciences. |
| CM: | Carnegie Museum. |
| CNHM: | Chicago Natural History Museum. |
| HUJ: | Hebrew University, Jerusalem. |
| IZUG: | Istituto di Zoologia Universita di Genova. |
| JG: | John Gasperetti. |
| MZUF: | Museo Zoologico de "La Specola" Universita di Firenze. |
| MHNG: | Museum d'Histoire naturelle, Geneve. |
| SMF: | Senckenberg Museum, Frankfurt a.M. |

Initials of collectors of material studied:

KAB – K. Al-Badry; KAK – Kadhim Al-Khalili; MAS – M. Al-Safadi; PA – Primrose Arnander; ENA – E. N. Arnold; AB – Arif Bey; KB – K. Blackwell; JB – Josef Bornmüller; MB – Marco Borri; JLB – J. L. Briggs; EBB – E. B. Britton; JEB – John Burchard; NRHB – N. R. H. Burgess; RJB – Richard J. Burton; GWB – G. Wyman Bury; WB – W. Büttiker; ISC – I. Sheila Collenette; GD – G. Doria; AD – Alan Drysdale; KGE – Kerrie Gotto Elsässer; AES – A. E. El Sherbiny; AAF – A. A. Farrag; HF – Henry Field; JF – J. Fernandez; SF – S. Flammer; RAF – R. A. Fraser; RBF – R. B. Fraser; MDG – M. D. Gallagher; JPG – J. & Patsy Gasperetti; PRG – Patricia R. Gasperetti; HBH – H. B. Hart; SBH – Scott & Blanche Harrison; DLH – David L. Harrison; BFH – B. F. Haythornthwaite; LH – Lucy Hill; EH – Emma Hill; HH – Harry Hoogstraal; ASGJ – A. S. G. Jayakar; WAK – W. A. King; REK – R. E. Kuntz; BK – Bill Kurtz; BL – Benedetto Lanza; JJL – John J. Lavranos; AAHL – Lorraine Legg;

Plate 1: Wadi Gizan Dam (elev. 100 m) about 15 km E of Hakimah. Aquatic biotope with at least four species of anura: *Bufo tihamicus, Bufo arabicus, Bufo dhufarensis* and *Euphlyctis ehrenbergii*. (Photo W. Büttiker).

Plate 2: Mountain biotope near An Namas (elev. 2380 m) in the central Asir, with shallow pools in depressions and small rivulets during and after rains. Habitat of Palaearctic relicts. (Photo W. Büttiker).

Plate 3: View from top of Al Dahna waterfalls (elev. 2250 m) in direction to Tanomah (Asir Province). Habitat of Palaearctic relicts. (Photo W. Büttiker).

Plate 4: Wetland in the Arabian Gulf coastal zone of Qatif (elev. 5 m). Reed biotope inhabited by *Rana ridibunda*. (Photo W. Büttiker).

Plate 5: Date palm plantation in the Hofuf oasis (elev. 150 m). Biotope inhabited by only *Rana ridibunda* of the amphibia as well as the pond turtle, *Mauremys caspica*. (Photo W. Büttiker).

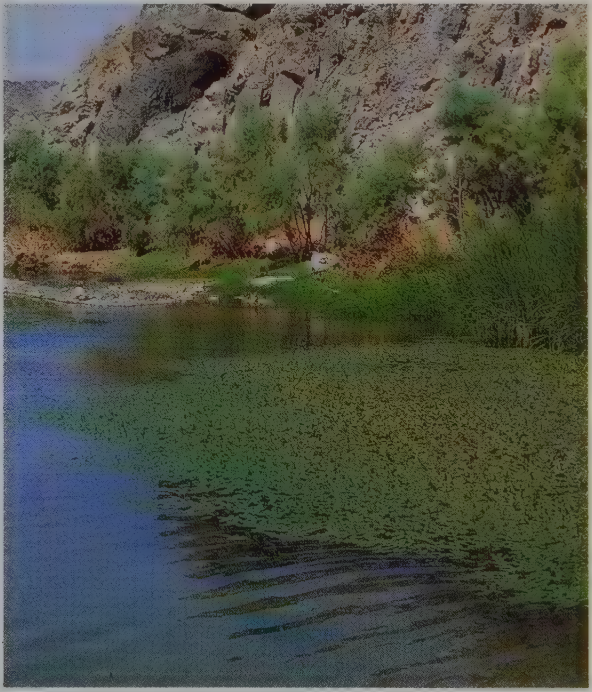


Plate 6: Biotope in Wadi Marwani (elev. 200 m) approximately 80 km N of Jeddah, with rich aquatic and riverine vegetation. Habitat of *Euphlyctis ehrenbergii* and *Bufo arabicus*. (Photo W. Büttiker).

CAL – Christopher Legg; DL – Digby Lickfold; EDL – Eloise Duffy Liddicoat; JL – Jon Lockhart; CHL – C. H. Lowe; WMM – W. M. Mann; PDM – Peter D. Manser; RSM – R. S. Mathews; SM – S. Moult; IAN – I. A. Nader; AKN – Abdul Karim Nasher; SSN – Sami S. Nawar; ON – Oskar Neumann; LP – L. Patterson; ABP – A. Blaney Percival; PWRP – P. W. R. Petrie; HStJBP – H. St. J. B. Philby; JCP – J. C. Phillips; DP – D. Phillips; MP – Marta Poggesi; GBP – G. B. Popov; MAR – M. A. Rahim; TDR – T. D. Rogers; GS – G. Scortecci; RS – Ray Semora; OS – O. Simoney; BGS – Ben G. Smith; ADS – Adam W. Smith; JWS John W. Smith; WT – Wilfred Thesiger; BT – Bertram Thomas; HBT – H. B. Tristram; DVF – D. Vesey-Fitzgerald; GV – G. Vogel; MVA – M. Von Au; HW – Hans Wachtel; W – Webster.

Other abbreviations:

| | | | |
|---|---|---|---|
| appr. | – approximate | mi. | – mile(s) |
| btwn | – between | nr | – near |
| km | – kilometer(s) | NSL | – near sea level |
| m | – meter(s) | spc(s) | – specimen(s) |

# KEYS

## Key to families

**Adults:**

| | | | |
|---|---|---|---|
| 1. | Finger tips dilated into rather large adhesive discs, tongue subcircular | **Hylidae** | |
| – | Finger tips not dilated or very feebly dilated, except in animals having a posteriorly cleft tongue . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | | 2 |
| 2. | Maxillary teeth absent, tongue subcircular | **Bufonidae** | |
| – | Maxillary teeth present, tongue posteriorly emarginate or cleft | **Ranidae** | |

**Tadpoles:**

| | | | |
|---|---|---|---|
| 1. | Anus slightly displaced to the right side of caudal membrane, eyes lateral, visible in ventral view | **Hylidae** | |
| – | Anus median, eyes dorsal, not visible in ventral view . . . . . . . . . . . . . . . . . . . . . . . . . | | 2 |
| 2. | Keratodonts set in ½; ⅓ or 1, 1+1/3 rows, in the latter case the two segments of the second row of the upper lip shorter than the gap between them | **Ranidae** | |
| – | Keratodonts always in ⅔ or 1, 1+1/3 rows, in the latter case the two segments of the second row of the upper lip always longer than the gap between them | **Bufonidae** | |

**Eggs:**

| | | | |
|---|---|---|---|
| 1. | Eggs in small rounded clusters, animal hemisphere greyish or brownish; maximum diameter 3–4 mm | **Hylidae** | |
| – | Animal hemisphere brown or black; eggs in strings or clusters; in the latter case individual eggs have a diameter of 7–8 mm or more . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | | 2 |
| 2. | Eggs in strings | **Bufonidae** | |
| – | Eggs in clusters | **Ranidae** | |

Fam. **Bufonidae** (adults):

1. A conical tarsal spur on the outer part of proximal third of tarsometatarsal segment of legs; metatarsal tubercles strongly keratinized, shovel shaped ***Bufo tihamicus***
– No tarsal spur; metatarsal tubercles small and not fully keratinized ............... 2
2. Snout clearly extending beyond the mandible, in lateral view (fig. 14); tympanum 70–80% of the horizontal diameter of the eye and in contact with the lower eyelid ***Bufo dhufarensis***
– Snout not extending beyond the mandible; tympanum smaller and more or less removed from the lower eyelid ............... 3
3. A continuous, flat, glandular ridge below the ulna; parotoid glands conspicuous, prominent, their length being for 22–26% of total body length ***Bufo viridis***
– Ulnar ridge, if present, formed by a row of clearly identifiable tubercles; parotoid glands flat 13–20% as long as the entire body ............... 4
4. No ulnar ridge; snout square tipped in both dorsal and ventral view; habit and fingers very slender; subarticular tubercles all simple ***Bufo scorteccii***
– Ulnar ridge interrupted, derived from the coalescence of a row of tubercles; snout roundly pointed in dorsal and ventral view; at least some double subarticular tubercles .... 5
5. Dorsal tubercles multispinose; first finger 40–50% as thick (at base) as its maximum length (fig.1); normally a couple of dark cross-bars on upper eyelids, males with a black internal vocal sac ***Bufo arabicus***
– Dorsal tubercles unispinose; first finger 30–40% as thick as long; no crossbars on upper eyelids, males with a white or greyish vocal sac ***Bufo hadramautinus***

Fam. **Ranidae** (adults):

1. Dorsolateral glandular folds present; fingers blunt; males with slitlike external vocal sac openings behing the mouth corners ***Rana ridibunda***
– No dorsolateral glandular folds; fingers acuminate; males with external vocal sac slit under the posterior part of mandible ***Euphlyctis ehrenbergii***

Fam. **Hylidae:**

1. One species in the Arabian peninsula; dorsal colour in life bright green ***Hyla savignyi***

Fam **Bufonidae** (larvae):

1. Upper caudal membrane ending anteriorly on the muscular part of tail, before it reaches the body ***Bufo viridis*** (European specimens)
– Upper caudal membrane ending at the base of the tail or on the body ............ 2
2. Second row of keratodonts above beak whole or very narrowly interrupted ........ 3
– Second row of keratodonts above beak rather widely interrupted ................. 4

3. Sides of caudal membranes tapering to the apex; interocular space only 1.2 times wider than internarial ***Bufo tihamicus***
– Sides of caudal membranes almost parallel; interocular space about 1.6 times wider than internarial ***Bufo scorteccii***
4. Upper caudal membrane ending on body, about level with the spiracular opening; tail less than 1.5 times as long as the body ***Bufo dhufarensis***
– Upper caudal membrane ending at base of tail; tail about twice as long as the body ***Bufo arabicus.***

The tadpoles of *Bufo hadramautinus* are unknown.

Fam. **Ranidae** (larvae):

1. Keratodonts set in ⅓ or 1, 1+1/3 rows; central part of lower oral disk with 1–2 series of papillae ***Rana ridibunda*** (European specimens)
– Keratodonts in ½ rows; no papillae on central part of lower oral disk ***Euphlyctis ehrenbergii***

## Genus *Bufo* Laurenti, 1768

*Bufo* Laurenti, 1768: 25. Type species: *Bufo viridis* Laurenti, 1768: 27, pl.1, fig. 1; by selection by Fitzinger (1843: 32). Invalid selection: *Bufo vulgaris* Laurenti, 1768: 28; by Mertens & Müller (1928: 18).
*Oxyrhynchus* Spix, 1824: 25. Type species: *Oxyrhynchus naricus* Spix, 1824: 49, pl. 4, fig. 2.
*Chaunus* Wagler, 1828: 744. Type species: *Chaunus globulosus* Wagler, 1828: 744; by selection by Fitzinger (1843: 32).
*Phryniscus* Wiegmann, 1835: 264. Type species: *Phryniscus nigricans* Wiegmann, 1835: 264.
*Osiolophus* Tschudi, 1838: 52, 89. Type species: *Rana typhonia* Linné, 1758: 211.
*Phrynoidis* Fitzinger, 1843: 32. Type species: *Bufo asper* Gravenhorst, 1829: 88.
*Phrynomorphus* Fitzinger, 1843: 32. Type species: *Bufo leschenaultii* Duméril & Bibron, 1841: 666, pl. 91, figs 1, 1a.
*Docidophryne* Fitzinger, 1843: 32. Type species: *Bufo agua* Daudin, 1802: 99, pl. 37.
*Peltophryne* Fitzinger, 1843: 32. Type species: *Bufo peltocephalus* Tschudi, 1839: 89.
*Otolophus* Fitzinger, 1843: 32. Type species: *Bufo margaritifer* Daudin, 1802: 89, pl. 33, fig. 1.
*Eurhyna* Fitzinger, 1843: 32. Type species: *Oxyrhynchus proboscideus* Spix, 1824: 52, pl. 21, fig. 4.
*Chilophryne* Fitzinger, 1843: 32. Type species: *Bufo dorbignyi* Duméril & Bibron, 1841: 697.
*Phryne* Fitzinger, 1843: 32. Type species: *Bufo vulgaris* Laurenti, 1768: 28.
*Anaxyrus* Tschudi, 1845: 78. Type species: *Anaxyrus melancolicus* Tschudi, 1845: 78, pl. 11, fig. 5.
*Schismaderma* Smith, 1849: 28 (app.). Type species: *Schismaderma lateralis* Smith, 1849: 28 (app.).
*Adenomus* Cope, 1860: 371. Type species: *Adenomus badioflavus* Cope, 1860: 371.
*Rhaebo* Cope, 1862: 357. Type species: *Rhaebo haematiticus* Cope, 1862: 157 (*Bufo haematiticus* Cope, 1862: 357).
*Epidalea* Cope, 1865a: 102. Type species: *Bufo calamita* Laurenti, 1768: 27.
*Otaspis* Cope, 1869: 312. Type species: *Peltophryne empusa* Cope, 1862: 344.
*Nannophryne* Günther, 1870: 402. Type species: *Nannophryne variegata* Günther, 1870: 402, pl. 30, fig. 1, 2.
*Cranopsis* Cope, 1876: 96. Type species: *Cranopsis fastidiosus* Cope, 1876: 96, pl. 23, fig. 1.
*Ollotis* Cope, 1876: 98. Type species: *Ollotis caerulescens* Cope, 1876: 98, pl. 23, fig. 3.
*Dromoplectrus* Camerano, 1879: 882. Type species: *Dromoplectrus anomalus* Camerano, 1879: 882.
*Ancudia* Philippi, 1902: 48. Type species: *Ancudia concolor* Philippi, 1902: 49.
*Aruncus* Philippi, 1902: 4. Type species: *Aruncus valvidianus* Philippi, 1902: 5.

Nomenclature and Systematics: The synonymic list reported above may be considered incomplete. Several names were omitted as they represent spelling variants of names proposed by earlier authors. As most of them are simply misspellings or unnecessary amendments, their omission should not produce serious nomenclatorial problems. However, it might be that some of them may subjectively

have nomenclatorial status, particularly as a consequence of the "one-letter difference" rule of the ICZN. All names that are of some possible consequence for the following discussion however, are listed.

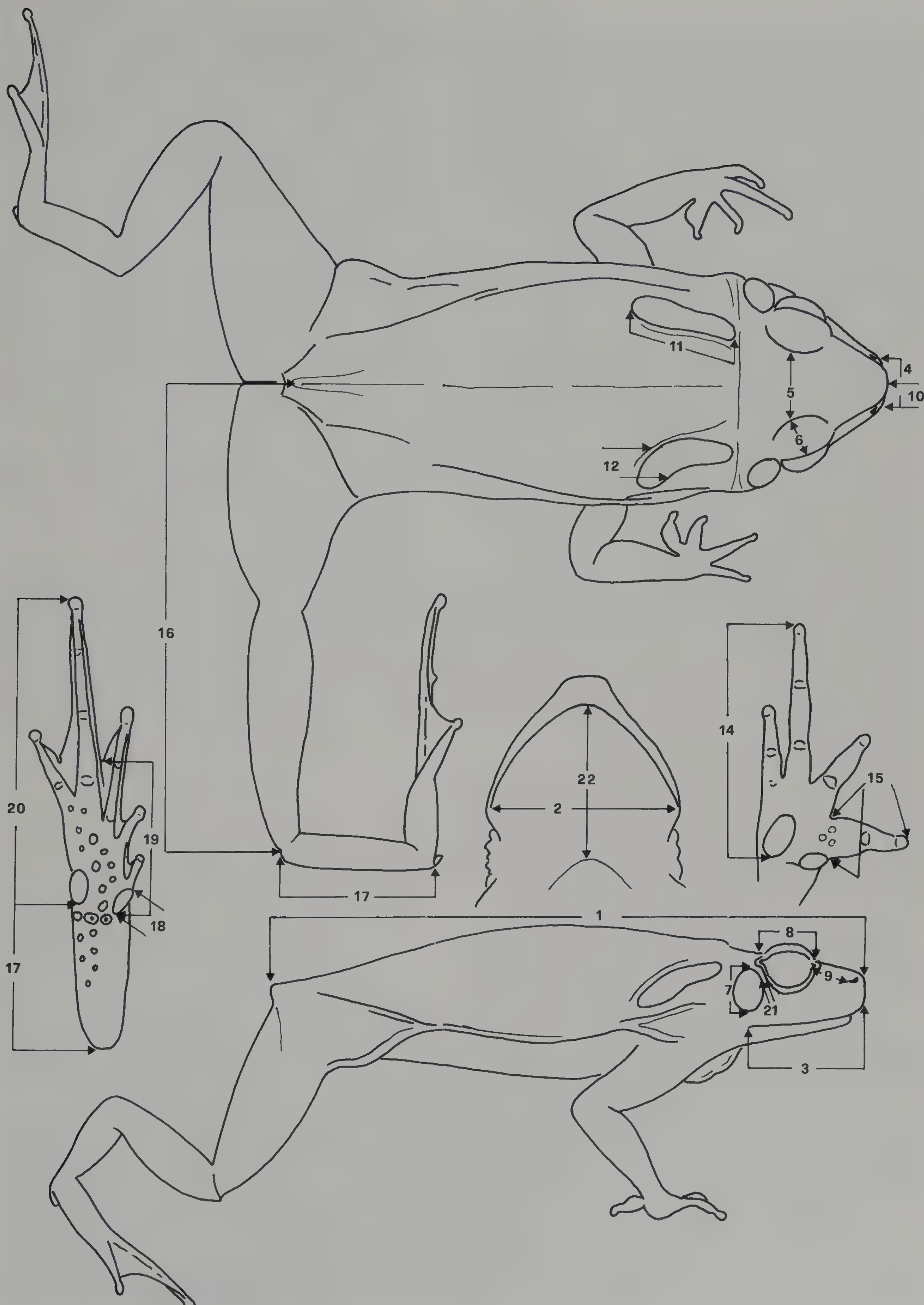
The synonyms listed above illustrate the extreme level of uncertainty that has surrounded the above species rank taxonomy of the genus *Bufo*. The evolutionary relationships of many species in the genus *Bufo* were revised recently (BLAIR, ed. 1972) on the basis of a multidisciplinary approach, taking into account all available evidence deriving from studies of the paleontology (TIHEN); osteology (MARTIN, INGER); karyology (BOGART); integument and myology (SZARSKI); various biochemical parameters (CEI et al., LOW, GUTTMAN); as well as from characteristics of their male mating calls (MARTIN, TANDY, BROWN) and hybridization experiments. In this way it was possible to sort out about a hundred species of this genus into well identified groups of species. However, the efforts of so many leading specialists failed to provide a comprehensive classification of species groups into phylogenetic lineages.

BLAIR (1972: 335–345), summing up the evidence derived from this multidisciplinary approach, recognised two main phylogenetic lineages. These are broadly identified by the relative dimensions of frontoparietal–bones, i.e. the "narrow-skulled" and the "broad-skulled" toads. This hypothesis is consistent enough with the osteological results obtained by MARTIN (ibid: 65–66), working mainly on species from the New World.

INGER (ibid: 111–115), revising the evolutionary relationships among the *Bufo* from Eurasia, based mainly on skeletal features, produced four alternative cladograms. The most parsimonious of them (his fig. 8–4) portrays three distinct lineages, the most important of which could be considered to represent the Eurasian radiation of the "narrow-skulled" toads. The other two are one "broad" and one "narrow-skulled", or the "*melanostictus* group" and the "*asper* group" respectively. These three lineages do not completely agree with evidence from other sources (MARTIN, BLAIR). The main assemblage "narrow-skulled toads", for instance (groups of *Bufo bufo, B. viridis, B. orientalis, B. stomaticus)* is shown to include also two "broad-skulled" species (*Bufo pentoni* and *Bufo mauritanicus*). As INGER did not consider the relative dimensions of frontoparietal bones among the characters he used for his study, referring individual species to one or another of BLAIR and MARTIN's groups is occasionally impossible. INGER's three main phylogenetic assemblages, however, are based on uniquely derived "apomorphic" characters: the absence of any kind of cranial crests (main lineage), the presence of an orbital crest only (*melanostictus* group), and the presence of double vertebral crests together with the loss of a supinator-manus-humeralis muscle (*asper* group), respectively. As the classification into "narrow-skulled" and "broad-skulled" species is substantiated by many other lines of evidence (chromosomal, blood–proteins, vocal type, testes types, hybridological and to some extent also from skin-secretion) it appears more likely that it may better reflect the phylogenetic history of *Bufo*. On the other hand several species groups, mainly from the African continent, remain unchecked or are of a doubtful position. Several more, particularly from South America, are considered intermediate between the two assemblages.

The taxonomic consequences of recognising the existence of these (two or more) phylogenetic lineages remain uncertain. A good deal of detailed scanning of morphological and biological characters is still necessary before the rather large and possibly heterogeneous assemblage of the genus *Bufo* can be properly divided into monophyletic subgeneric units.

Fig. 1: Measurements referred to in the text. 1, Snout to urostyle.– 2, Width of head.– 3, Length of head.– 4, Interarial distance.– 5, Interorbital space.– 6, Width of upper eye-lid.– 7, Vertical diameter of tympanum.– 8, Horizontal diameter of the eye.– 9, Minimum distance from nostril opening to anterior corner of eye.– 10, Minimum distance from nostril opening to tip of snout.– 11, Length of paratoid gland.– 12, Width of paratoid gland.– 13, Length of arm to wrist.– 14, Length of hand.– 15, Width/length of first finger of hand.– 16, Length of hind limb to tibio-tarsal articulation.– 17, Length of tarsus.– 18, Length of metatarsal tubercle(s).– 19, Webbing.– 20, Length of foot.– 21, Minimum distance from the eye to the tympanum.– 22, Elongation of mandible.



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Apart from the taxonomic position of the South African *Bufo carens,* which is alleged to be greatly removed from all other *Bufo,* both by morphological and biological characters, and for which the subgeneric(?) name of *Schismaderma* Smith, 1849 may be available, we shall not consider any further partitioning. In the event that such a division should be realised to be necessary, most species of *Bufo* of the Arabian peninsula are probably to be referred to *Bufo* s.str. (Eurasiatic "narrow-skulled toads": *Bufo viridis, Bufo arabicus, Bufo dhufarensis, Bufo scorteccii, Bufo hadramautinus).* Only *Bufo tihamicus* would be part of the African "broad-skulled" complex, because of its close relationship to *Bufo pentoni* and, through the latter, possibly to *Bufo mauritanicus* (Inger 1972: 110). As *Bufo mauritanicus* (the karyotype of *Bufo pentoni* is unknown) represents the only 22-chromosome species among the African "broad-skulled" toads *(Bufo regularis, Bufo latifrons, Bufo maculatus, Bufo perreti* species complexes all having 2n=20 derived character), their relationship rests mostly on skeletal and hybridological data. From the nomenclatorial point of view, there is no available genus-group name to designate the African "broad-skulled" lineage. Even if they are related to the Asiatic complex of *Bufo melanostictus* (sensu Inger) no name would be available, either. The oldest available name for the American "broad-skulled" toads is *Oxyrhynchus* Spix, 1824 (type species: *Oxyrhynchus naricus* Spix, 1824 – a junior subjective synonym of *Bufo typhonius [Rana typhonia* Linné, 1758]) which name might be employed to designate the entire "broad-skulled" complex.

Finally, the oldest genus group name available to designate the "narrow-skulled" Asiatic complex of *Bufo asper* (sensu Inger), is *Phrynoidis* Fitzinger, 1843 (type species: *Bufo asper* Gravenhorst, 1829). *Phryniscus* Wiegmann, 1834 (type species: *Phryciscus nigricans* Wiegmann, a synonym of *Bufo spinulosus* Wiegmann, 1834, fide Cei (1980: 164) may be the oldest available name to designate the American narrow-skulled complex. Its next possible synonym is *Anaxyrus* Tschudi, 1845 (type species *Anaxyrus melancholicus* Tschudi, 1845, a junior subjective synonym of *Bufo compactilis* Wiegmann, 1833), and might be used if *Bufo spinulosus* were to be removed from the narrow-skulled line because of its "intermediate position" (Martin 1972: 65). As previously stated, however, in the present situation and lacking a complete taxonomic revision, none of these names will be used in this work, but are presented for further consideration.

### ***Bufo tihamicus*** Balletto & Cherchi, 1973

*Bufo pentoni* Anderson, 1893: 440.– Anderson 1895 : 662; Anderson 1901 : 152; Haas 1957 : 50; Balletto & Cherchi 1971: 30; Tandy 1972: 199; Tandy & Keith 1972: 160.

*Bufo pentoni tihamicus* Balletto & Cherchi, 1973: 114.

*Bufo pentoni tihamicus* Balletto & Cherchi.– Arnold 1980: 276.

Holotype: Zug 2, ♂, Sukhnah (north Yemen), 14°48'N 43°26'E, 350 m, G. Scortecci 19.VIII. 1965 (see map, fig. 2: 9).

Other material (109 specimens, 75 larvae; see map, fig. 2): 1: Lahij, 13°04'N 44°53'E, 150 m, BM(NH) 95.5.23.105–110, JWY c. 1895 (Anderson 1895); idem, BM(NH) 99.12.13.94–96, ABP 1899 (Anderson 1901). – 1: Haithalhim, 13°06'N 44°53'E, 200 m, BM(NH) 95.8.23.112, skeleton, JWY c. 1895 (Anderson 1895). – 2: Abyan Country, 13°10'N 45°20'E, 50 m, BM(NH) 99.12.13.97–98, ABP 1899 (Anderson 1901). – 3: nr Mt. Manif, 13°17'N 44°51'E, BM(NH), 3 spcs, ABP 1899 (Anderson 1901). – 4: Bir Hathah, 19°21'N 41°07'E, 70 m, CAS 102384–388, JG 30.IV.1965. – 5: 20 km S of Masliyah, 17°18'N 42°35'E, NSL, CAS 102390, JG 27.XI.1965. – 6: Al Lith, 20°09'N 40°17'E, NSL, CAS 119214, JG 27.X.1965. – 7: nr Khasawiyah 16°56'N 42°37'E, 25 m, CAS 134170–171, JG XII.1971/I.1972. – 8: Al Bazra, 14°51'N 42°59'E, IZUG, 3 ♂♂ 10 ♀♀, GS sum. 1965. – 9: Sukhnah (see above), IZUG, 10 ♂♂ 13 ♀♀ 75 larvae, GS VIII. 1965. – 10: Bir Hebn al Uan, 13°18'N 43°20'E, 75 m, IZUG, 2 ♂♂, GS sum. 1965. – 11: Wadi Zabid, 14°12'N 43°19'E, 100 m, BM(NH) 1963.817,819,820,

**Table 1: Selected taxonomic characters of Arabian species of *Bufo*.**

| No. | *B. tihamicus* | | *B. dhufarensis* | | *B. viridis* | | *B. arabicus* | | *B. hadramautinus* | | *B. scorteccii* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1.53 | (3) | 1.15 | (0) | | (0) | 1.29 | (1) | 1.42 | (2) | 1.40 | (2) |
| 3 | 0.66 | (3) | 0.36 | (0) | | (1) | 0.49 | (1) | 0.42 | (0) | 0.44 | (0) |
| 5 | 0.81 | (6) | 0.55 | (1) | | (3) | 0.72 | (5) | 0.69 | (4) | 0.80 | (6) |
| 7 | rugose | (2) | smooth | (0) | smooth | (0) | smooth | (0) | smooth | (0) | smooth | (0) |
| 8 | separate | (0) | not sep. | (1) | not sep. | (1) | not sep. | (1) | not sep. | (1) | not sep. | (1) |
| 9 | one half | (2) | complete | (3) | complete | (3) | variable | (⅓) | complete | (3) | complete | (3) |
| 10 | closed | (2) | open | (0) | open | (0) | ⅔ closed | (1) | open | (0) | open | (0) |
| 11 | broad | (1) | broad | (1) | narrow | (0) | narrow | (0) | narrow | (0) | narrow | (1) |
| 12 | fused | (1) | fused | (1) | fused | (1) | separated | (0) | separated | (0) | separated | (0) |
| 13 | complete | (3) | ⅔ fen. | (2) | none | (0) | ⅓ fen | (1) | ⅓ fen | (1) | ⅔ fen | (2) |
| 16 | ipt<pf | (2) | ipt<pf | (2) | ipt<pf | (2) | ipt>pf | (0) | ipt<pf | (2) | ipt>pf | (0) |
| 17 | feeble | (0) | feeble | (0) | feeble | (0) | feeble | (0) | feeble | (0) | feeble | (0) |
| 18 | smooth | (0) | smooth | (0) | smooth | (0) | smooth | (0) | smooth | (0) | smooth | (0) |
| 19 | 0.89 | (0) | 0.94 | (1) | | (0) | 0.84 | (1) | 0.96 | (1) | 1.00 | (1) |
| 20 | 0.73 | (1) | 0.47 | (1) | | (0) | 0.73 | (1) | 0.75 | (1) | 0.70 | (0) |
| 21 | 0.39 | (3) | 0.42 | (3) | | (3) | 0.45 | (3) | 0.37 | (1) | 0.52 | (4) |
| 23 | one | (1) | one | (1) | one | (1) | one | (1) | one | (1) | one | (1) |
| 29 | none | (0) | none | (0) | none | (0) | none | (0) | none | (0) | none | (1) |

Explanation: Characters (No.) and character states (in parenthesis) are according to classifications introduced by Inger (1972). 2. Skull width measured at the ventral end of the suspensorium / skull length measured from the opening of the foramen magnum to anterior end of internasal suture.– 3. Skull height measured from the ventral articular surface to the supraoccipital surface / skull length.– 5. Brain case depth measured at anterior end of occipital arterial canals / brain case width measured between the anterior ends of the occipital canals.– 7. Rugosity of dorsal surface of skull. Variable: 0 = smooth; 1 = pitted; 2 = rugose.– 8. Separation of frontoparietals: 0 = bones joined by a hairline suture; 1 = bones separated by a narrow parallel-sided space; 2 = widely separated in the anterior ½–⅔ to form an irregular sided fontanelle, i.e., "separated".– 9. Dorsal exposure of sphenethmoid, indicating degree of fusion between frontoparietals and nasals as follows: 0 = not exposed dorsally (frontoparietals abutting nasals); 1 = exposed in a small area of the dorsal midline; 2 = exposed for about ½ the width of the snout; 3 = exposed the full width of the snout.– 10. Canal of the occipital artery from the supraoccipital region to the posteromedial corner of the orbit showing as follows: 0 = completely exposed, appearing as a groove in the dorsal surface of the skull; or, a narrow sliver of bone arched over the canal at one of its ends; 1 = ¼ to ½ of canal covered by bone; 2 = canal covered by bone its entire length.– 11. Dorsal otic plate of squamosal broad and overlying the prootic; or, merely overlies the lateral edge of the prootic not forming an otic plate or a narrow otic plate.– 12. Fusion or separation of the frontoparietal and prootic bones.– 13. Overlap of the quadratojugal on the maxilla from dorsolateral view gauged in terms of the pterygoidal fenestra: 0 = no overlap; 1 = overlap slight, tip of quadratojugal not reaching anterior ½ of pterygoidal fenestra; 2 = tip of quadratojugal in anterior ½ of the pterygoidal fenestra; 3 = tip of quadratojugal reaching pterygoid.– 16. Comparison of angle or angles (when skull viewed from the rear) formed between the pterygoid and the parasphenoid, or between the quadratic and parasphenoidal arms of the pterygoid or at both points noting: 0 = intrapterygoid (ipt) greater than; 1 = equal to; or, 2 = smaller than, the pterygoid-parasphenoid (pf) angle.– 17. Ridge across the transverse posterior axis of the parasphenoid: 0 = absent, i.e., flat parasphenoid; 1 = shallow, obtuse ridge; 2 = deep, broad obtuse ridge; 3 = narrow, deep sharp ridge.– 18. Palatine denticulation: 0 = smooth; 1 = slightly undulate; or 2 = denticulate, notched.– 19. Length of 3rd transverse process of vertebral column measured from tip to tip / skull length.– 20. Length of 7th transverse process of vertebral column measured from tip to tip / 3rd transverse process (19, above).– 21. Width of the 8th sacral diapophysis / skull length.– 23. Vertebral crests. Some Bufonids have 2 parallel dorsal ridges from the 3rd to 7th vertebrae; most, however, have a single low dorsal crest.– 29. External cranial crests, cornified with raised edges curved or straight with the skin of the crest usually fused to the underlying bones: 0 = no crests; 1 = canthal crest only; 2 = supratympanic crest only; 3 = orbital crests only; 4 = orbital crests plus supratympanic; 5 = orbital crests plus supratympanic plus parietal crests.

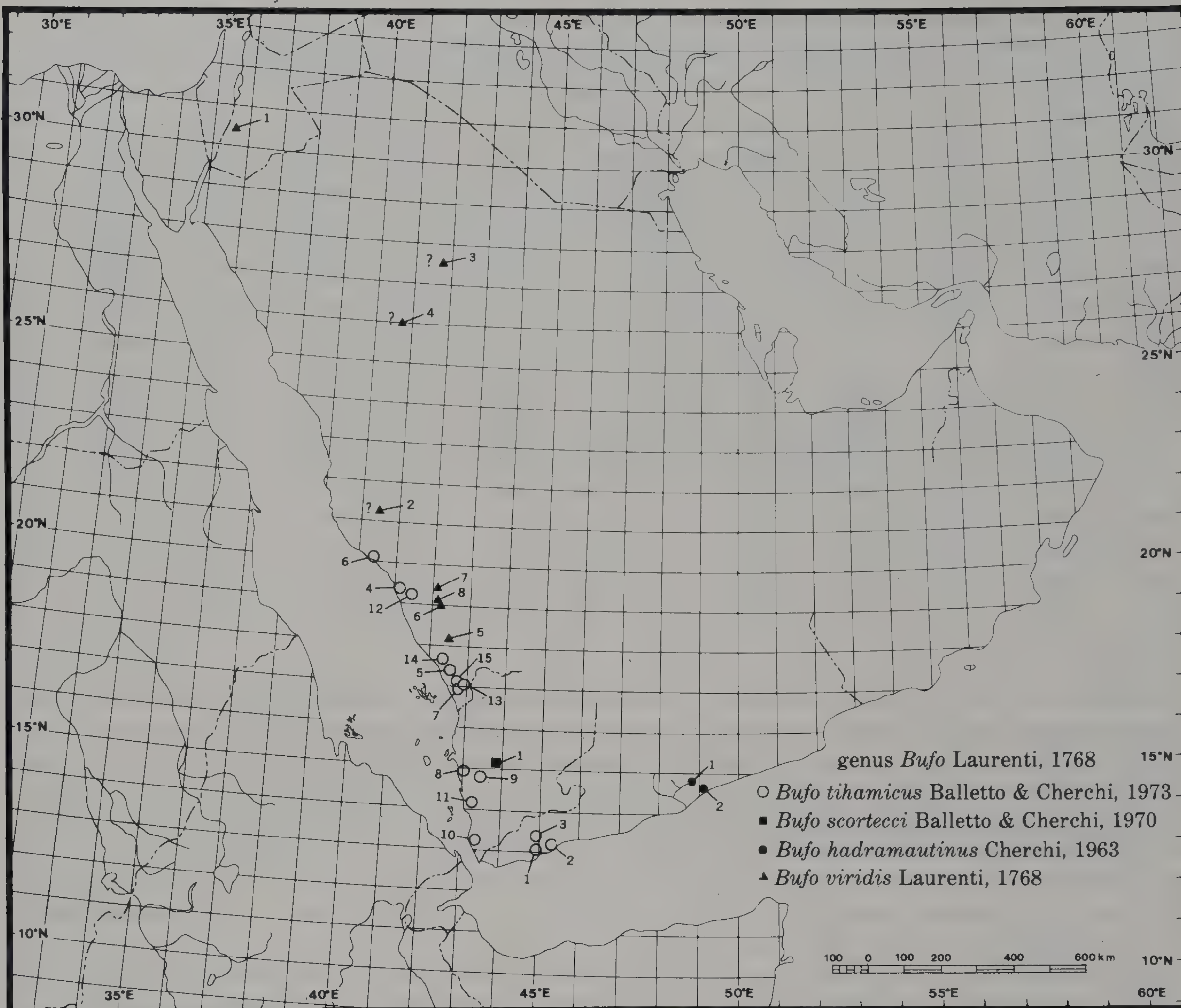


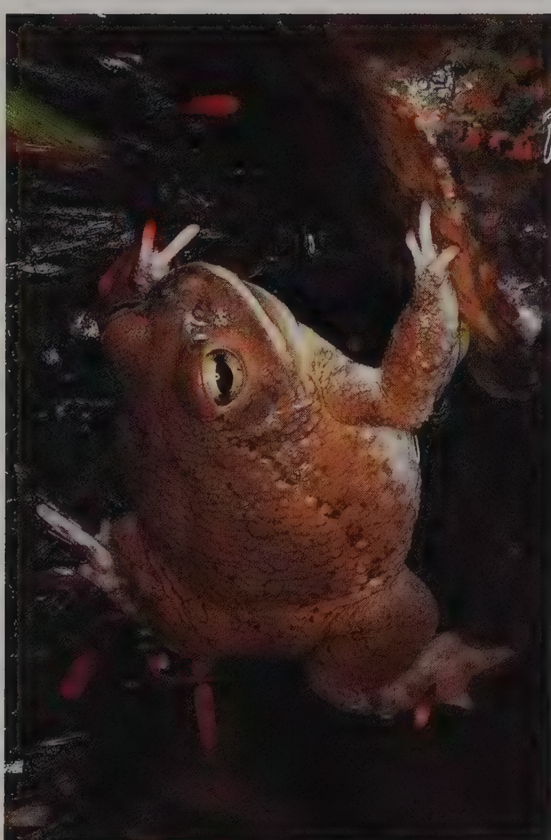

Fig. 2: Distribution of *Bufo tihamicus* (circle), *Bufo scortecci* (square), *Bufo hadramautinus* (dot) and *Bufo viridis* (triangle).

juv., GBP 1963. – 12: Wadi Lanshiba, 19°20'N 41°20'E, 300 m, BM(NH) 1964.581, ♀, DVF 1964. – 13: Hakimah, 17°01'N 42°50'E, 80 m, BM(NH) 1979.651–682, JG, RAF, RBF 1.XI.1979; idem BM(NH) 1980.124–127, JPG 5.I.1979. – 14: Ad Darb, 17°43'N 42°15'E, 70 m, BM(NH) 1977.379, CHL c. 1977; btwn Aden and Abyan (?), BM(NH) 1978.1280–83 ?. – 6: nr Al Lith (see above), BM(NH) 1979.934, AAF c. 1979. – 15: Abu Arish – Sabya Rd, 17°04'N 42°42'E, 50 m, BM(NH) 1978.898–900, JG 1978.

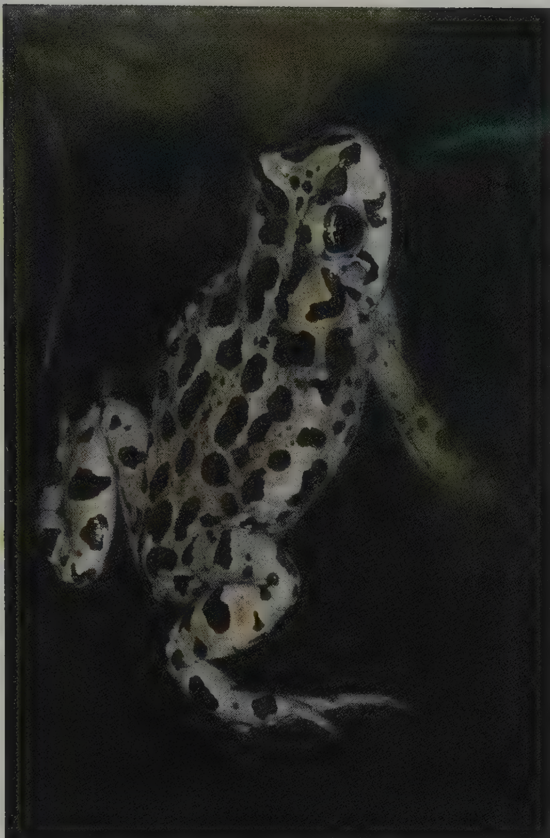
Jabal Barad, 21°08'N 40°13'E, 1900 m, BM(NH) 1978.895–897, JG c. 1978. Thamniah 18°01'N 42°45'E, 2380 m, BM(NH) 1982.239, WB c. 1982. (Jabal Barad and Thamniah are not localities of *Bufo tihamicus* indicating an error of labelling, transcription or other lapsus calami; positions not mapped.)

Description: A rather small species of *Bufo,* up to 66.5 mm long from snout to urostyle. Habit very stout. Colour of the dorsal parts (in alcohol) light greyish-brown to ash-grey, occasionally mottled darker on dorsal, tubercles, or marbled by large, irregular spots. In some specimens some whitish markings, in the shape of dorsolateral bands or of an inverse V behind the shoulder blades, may be present.

Limbs more or less obscurely marked by cross-bars, dorsally. A vertical bar may be present on the


7a


7b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Plates 7–8: 7 a–b, *Bufo tihamicus*; 8 a–b, *Bufo viridis*.

upper lip under the eye. Metatarsal tubercles, finger and toe-tips often dark brown. Ventral parts whitish or yellowish. Dorsal skin strongly granulose by the presence of many prominent, conical warts, each bearing a central spine. In some specimens, particularly in females, dorsal tubercles are more or less reduced in number, or in some specimens, flattened. Two rather interrupted dorsolateral glandular ridges, running from beneath the tympanum to the groin. A well defined tarsal fold and a similar glandular ridge on the ulna.

Head massive, comparatively short and very broad, its length 70–73% of its width and 26–29% of total body length. Snout feebly projecting beyond the mandible, truncate in dorsal view and gently sloping in a downwards curve, when seen from the side. Nostrils at the fore corners of the snout, about level with its tip, the internarial distance is about 85% of the interorbital space, which is approximately 88% of the width of the upper eyelid. Tympanum moderately large, subcircular, its maximum diameter 55–70% of that of the eye; the distance between eye and tympanum is 14–17% the horizontal diameter of the tympanum. The minimum distance from the nostril opening to the tip of snout is half (46–54%) of that from the nostril to the anterior eye corner, which distance is about 55% of the horizontal diameter of eye. Paratoid glands flattened but distinct, their length 16–22% of total body length. Males with a single, internal vocal sac, surrounded by black pigmented muscles, not, or scarcely, showing through the gular teguments.

Limbs short and stout. Hand small, fingers comparatively thick, the first, measured at base, is 50% (or more) as wide as its length. Subarticular tubercles rather small, always simple. Only one, not particulary large or conspicuous, palmar tubercle (a second one, at the base of the first finger, being scarcely definite or small). Hind limb short, 68–72% of total body length when measured to the tibio-tarsal articulation; when extended forward along the body, the tibio-tarsal joint reaches the axilla, or the shoulder. Tarsus about 30% as long as the hind limb. Foot about 60% of femur and tibia, webbed to about one half of the first phalange of the fourth toe. Metatarsal tubercles prominent, spade shaped, dark brown to black. A similar dark brown tubercle in the middle of the proximal third of tarsus.

The skeleton of *Bufo tihamicus* is characterized by a very broad skull (fig. 3), its maximum width being 1.53 times its length, 0.66 times as high as long. The ratio of depth to width of braincase is 0.81. Frontoparietals rugose and deeply pitted; nasal bones also rugose but less extensively pitted. Frontoparietals separated by a narrow paralled-sided space; sphenethmoid exposed dorsally by about half the width of the snout. Canal of the occipital arteries covered by bone for their entire length. Dorsal otic plate of squamosal overlying the prootic by about ⅓ of its length. Quadratojugal overlapping the maxilla over the entire length of the maxilla, the distal end reaching the pterygoid. Pterygoid-parasphenoid angle larger than the angle between the quadratic and parasphenoidal arms of the pterygoid, when the skull is viewed from the rear. A shallow, obtusely rounded ridge along the transverse process of the parasphenoid bone; palantines smooth. Vertebral column rather narrow, the width of the transverse process of the third vertebra, measured from tip to tip, is about 89% the skull length; the seventh transverse process is 0.73 times as long as the third one; the diapophysis of the 8th (sacral) vertebra is 39% as wide as the skull length. A single, median, vertebral crest formed by the dorsal neural spines.

Variation: Sexual dimorphism in *Bufo tihamicus* is not very strong but clearly visible. Males can be easily recognised by their double keratinisation on the outer part of first finger. The subgular vocal sac is not always visible through the gular teguments and its examination may require dissection. Size difference between sexes is not great, however, males are normally rather smaller, measuring 43–48 mm from snout to urostyle, while mature females are 44–65.3 mm long. Other measurements show very little variation between sexes. Several biometrical data are reported in a previous paper by Balletto & Cherchi (1973).

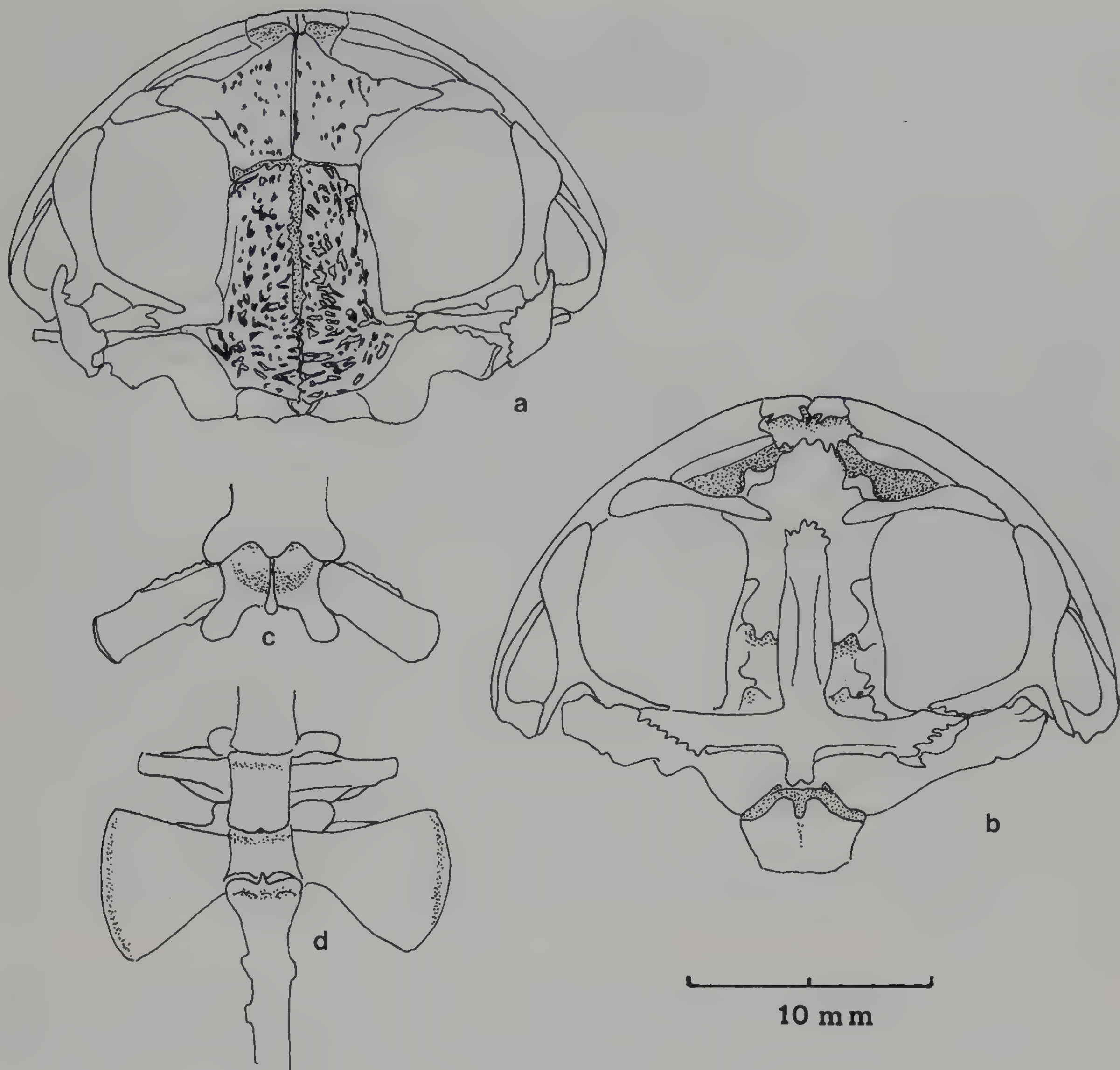


Fig. 3: Skeletal features of *Bufo tihamicus* from Al Bazra, ♀ (IZUG). a, Dorsal and b, ventral views of skull. c, 3rd vertebra from dorsal view. d, 7th and 8th (sacral) vertebrae from ventral view.

Tadpole: Some 75 larvae [stages 25–35 according to Gosner's (1960) classification] (fig. 4) apparently referable to *Bufo tihamicus* were collected at Sukhnah, 19.VIII.1965 (G. Scortecci leg.), where *Bufo tihamicus* is sympatric with *Bufo arabicus* Heyden and *Bufo dhufarensis* Parker. The tadpoles of these three species share some aspects of external morphology. However, they differ by their colour, by some biometrical characters, labial formula, and shape of tail. The largest tadpole in this small collection measures 20.2 mm from snout to the tip of tail. Colour in alcohol is light reddish-brown, which extends from the region above the chondrocranium to the muscular part of the tail. The upper caudal membrane may have some speckles of the same colour. Ventral parts and lower caudal membrane are colour-

less and transparent. Nostrils are set about midway between the eye and the snout tip, in dorsal view, but much closer to the eye when viewed laterally; the internarial space is about 82% of the interorbital distance; the eye diameter is 11% of the body length; the distance from the pupil to the snout tip is about 50% of that to the base of legs, and equal to that from the spiracle. The spiracle is on the left side of the body, directed backwards and upwards, ventrolateral and not visible from above, set at about 65% of the body length. Body length is about 40% of total length, in a tadpole with little developed hind limbs. The anus is median. The tail is obtusely tipped, the upper caudal membrane scarcely convex, tapering; it extends on the body up to about the same level as the spiraculum. In the larval mouth, rostrodonts are rather curved and sclerotised, finely toothed in the middle. Keratodonts are set in five rows: two on the upper lip and three on the lower one. Of those on the upper lip, the second may be continuous or very narrowly interrupted in the middle. Under strong magnification keratodonts show the normal flat-fringed tip that is commonplace in the genus *Bufo.*

Systematics: *Bufo tihamicus* is closely allied to *Bufo pentoni* Anderson, from which it differs mainly in its smaller size (average 53.3 mm and 58.1 mm respectively); a comparatively smaller internarial space, only about 80% of the width of the upper eyelid, rather than about 90% of it; a tympanum slightly more removed from the eye being thinly, but constantly separated from the lower eyelid, rather than being in contact with it; and by its more flattened smaller parotoid glands, by its much more definite tarsal fold, normally invisible and very ill defined in *Bufo pentoni;* and by its flattened but continuous and clearly identifiable ulnar ridge, which is undefined or poorly defined in *Bufo pentoni*. The characteristics allowing the distinction between the two species remain fairly constant over the whole Sahelian range of the African *Bufo pentoni* from Mauretania to Burkina Faso, Nigeria, Chad, Ghana and Sudan. The same can be said of the Arabian counterpart *Bufo tihamicus* in its known peninsular distributional area. Even though it can be safely assumed that both *Bufo pentoni* and *Bufo tihamicus* originated from a common stock, it is certain that no gene flow can occur between them. Lacking direct evidence from hybridization studies or estimates of times of divergence on electrophoretical basis; the consideration of whether *Bufo pentoni* and *Bufo tihamicus* are distinct at the species or subspecies level is an issue of a more or less subjective nature. However, their geographic separation is a strong argument for specific recognition.

Ecology: *Bufo tihamicus* is found along the coastal littoral from near Al Lith (20°N) southerly to the south-west end of the peninsula then eastward to the vicinity of Aden mainly at elevations less than 400 m. This coastal area, known as the Tihama, is made up of intermittent stretches of alluvial fans and sand wastes, sporadically incised by the water courses that debouch generally, onto the playas or sabkhas nearer the coast. The arable lands fringe the wadis, and it is in these areas that *Bufo tihamicus* is in greatest abundance together with *Bufo arabicus* (in small numbers) and *Bufo dhufarensis* (in greater numbers) as well as *Euphylctis ehrenbergii.*

Though the annual rainfall on the Tihama is less than 100 mm, the isohyetal curve turns up sharply with increased elevation and only 40–100 km from the sea where elevations attain 2000–3000 m the annual precipitation may be as high as 1000 mm (Gasperetti & Whitney 1983, pl.1). It is this rainfall that feeds the lowlands, recharges the ground waters and contributes to the growth of relatively abundant vegetation. From the high mountain areas, there is a swift runoff of rainwater and often devastating floods that sometimes reach the sea. In the wake of the floods, which are very much localised, occuring in late winter or early spring, are perennial pools and ponds that afford excellent, if limited ecosystems of which the few anuran species are an important integral part.

Because of extreme diurnal temperatures, *Bufo tihamicus* is active mainly at night, especially where there may be irrigation activities or standing water from irrigation drainage, recent rains or other sources. During the day it seeks shelter in rock piles, burrows, under rocks, etc.

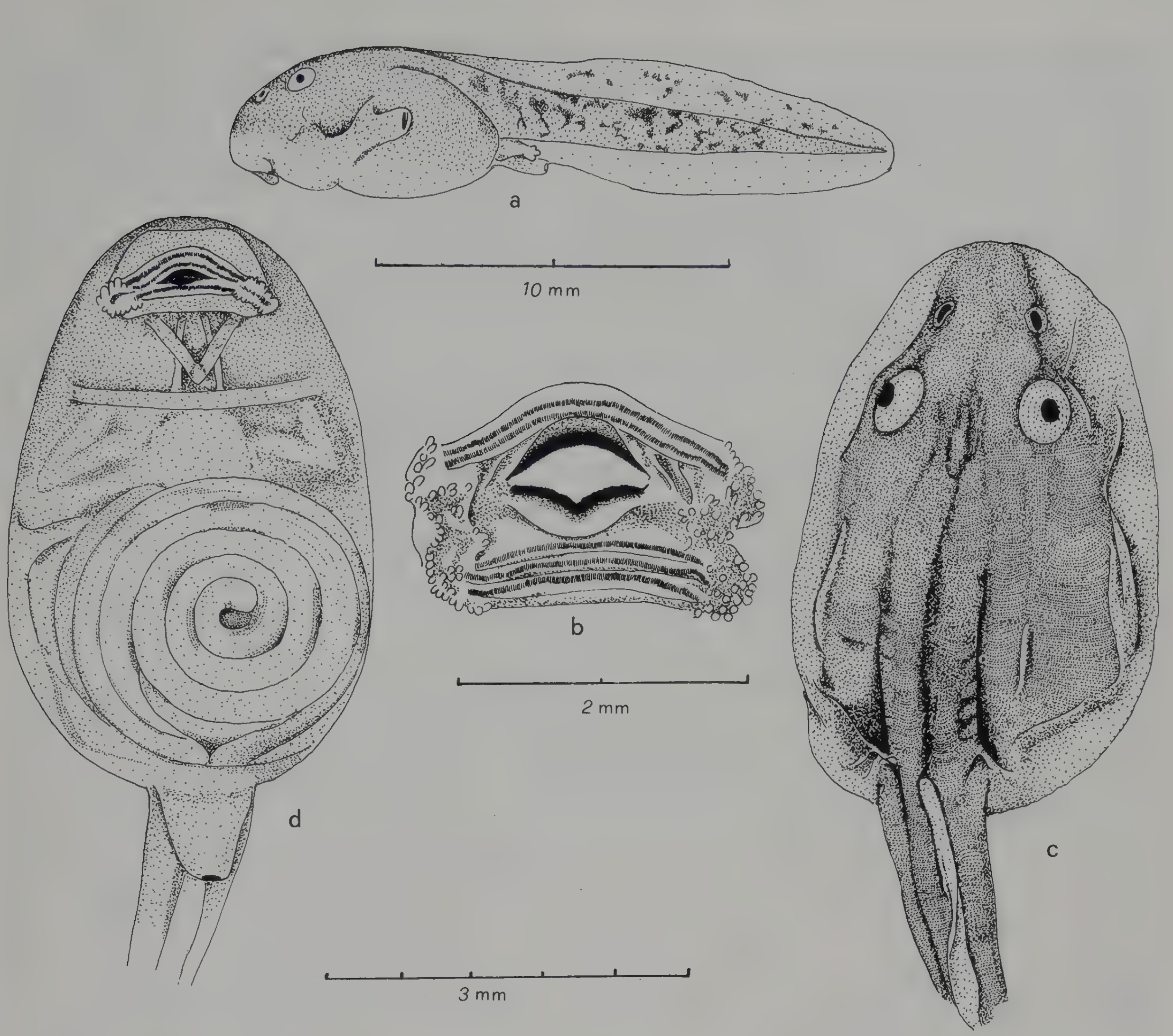


Fig. 4: Tadpole of *Bufo tihamicus* from Sukhnah (IZUG). a, Lateral view of tadpole. b, Larval mouth. c, Dorsal and d, ventral views of tadpole.

***Bufo dhufarensis*** Parker, 1931

*Bufo andersonii* Boulenger, 1883: 163. – Boulenger 1887: 408; Anderson 1895: 662; Anderson 1896: 55; Anderson 1901: 152.

*Bufo dhufarensis* Parker, 1931: 518.

*Bufo dhufarensis* Parker. – Parker 1938: 491; Haas 1957: 50; Haas & Battersby 1959: 198; Balletto & Cherchi 1970: 27; Balletto & Cherchi 1971: 29; Arnold & Gallagher 1977: 71; Arnold 1980: 275.

Holotype: BM(NH) 1931.7.16.1, ♀, Milwah al Aud, 17°08′N 54°19′E, 65 m, B. Thomas 1.XII.1930 (see map, fig. 5: 4).

Other material (221 specimens, 137 larvae; see map, fig. 5): 1: Muscat, 23°37′N 58°35′E, NSL, BM(NH) 85.11.7.33, ♀, ASGJ (Boulenger 1887). – 2: Haithalhim, 13°06′N 44°53′E, 200 m, BM(NH) 95.5.23.102–104, 3 juv. 1 larva, JWY (Anderson 1895); Hadramawt (?), BM(NH) 97.3.11.128–129, larvae, JTB 1896 (Anderson 1896). – 3: Sheikh Othman, 12°52′N 44°59′E, NSL, BM(NH) 99.12.13.93, ♂, JWY (Anderson 1901). – 4: Shaib Usaila, 20 mi. from Jidda (?), BM(NH) 1934.11.8.2–3, juvs, HStJBP (Parker 1938). – 5: Makkah, 21°27′N 39°49′E, 270 m, BM(NH) 1934.11.8.1, ♂ & BM(NH) 1938.2.114,

♂, HStJBP c. 1935 & 9.III.1936 (Parker 1938). – 6: Buraymi, 24°15′N 55°45′E, 275 m, HUJ 526, DVF 1944 (Haas 1957)[5]. – 12: "Wadi Hadramawt" (= Sayun), 15°56′N 48°47′E, 600 m, BM(NH) 1953.1.6.65–66, GBP 1950/1953. – 7: Dis, 14°32′N 49°08′E, NSL, IZUG, 6 ♀♀ 6 ♂♂, GS spr. 1962. – 8: Al Matuar, 15°34′N 48°07′E, 600 m, IZUG, 2 ♂♂, GS spr. 1962. – 9: Ingrams, 14°36′N 49°01′E, 760 m, IZUG, 1 ♂, GS 30.IV.1962. – 7: Mukalla, 14°32′N 49°08′E, NSL, IZUG, 2 ♀♀ 3 ♂♂, GS spr. 1962. – 10: Shibam 15°54′N 48°23′E, 600 m, IZUG, 1 ♀ 44 ♂♂, GS spr. 1962. – 11: Ba Safa, 14°23′N 47°25′E, 760 m, IZUG, 1 ♀, GS spr. 1962. – 7: Al Baqrayn, 14°34′N 49°07′E, 100 m, IZUG, 1 ♀ 2 ♂♂, GS spr. 1962; Al Uassac (?), IZUG, 1 ♀, GS spr. 1962. – 12: Al Ghurfah, 15°54′N 48°44′E, 600 m, IZUG, 2 ♀ 5 ♂♂ 41 larvae, GS spr. 1962. – 13: Al Bazra, 14°51′N 42°59′E, NSL, IZUG, 2 ♀♀ 1 ♂, GS sum. 1962. – 14: Sukhnah, 14°48′N 43°26′E, 350 m, 5 ♀♀ 5 ♂♂, GS VIII.1965. – 15: Bir Hebn al Uan, 13°18′N 43°20′E, 75 m, IZUG, 1 ♂, GS sum. 1965. – 16: Khasawiyah, 16°56′N 42°37′E, 25 m, CAS 134168–169, JG, RBF XII.1971/I.1972. – 17: Hayr, 24°23′N 46°50′E, 550 m, CAS 136561-564, JG, JEB 1.VI.1972. – 18: Wadi Buwwah, 20°46′N 41°12′E, 1400 m, CAS 139734-735, JG 25.IX.1974. – 19: Wadi Qid, 23°12′N 58°37′E, 460 m, BM(NH) 1975.897, DLH 21.IV.1975 (Arnold & Gallagher 1977). – 1: Wadi Kebir, 23°36′30″N 58°34′E, 60 m, BM(NH) 1975.874–885, MDG 19.III.1975 (Arnold & Gallagher 1977).– 20: Hakimah, 17°01′N 42°50′E, 80 m, CAS 140448–449, JG 4.VII.1975. – 21: Wadi Marabah, 17°54′N 42°23′E, 450 m, CAS 140470–472, PRG 8.VI.1975. – 21: idem, BM(NH) 1978.890, JG 1978. – 22: Makkah by-pass km 126.5, 21°19′N 40°00′E, 300 m, BM(NH) 1979.922–925, JPG, JJL 26.III.1980. – 23: Wadi Mahra, 19°38′N 41°55′E, 1900 m, BM(NH) 1979.634–635, RAF 29.X.1979. – 24: Ayn Markub, 20°33′N 40°09′E, 220 m, BM(NH) 1978.2014–023, JG, AKN, ISC 29.III.1979. – 20: Hakimah (see above), BM(NH) 1979.636–637, WB 15.X.1979. – 25: Wadi Shumran, 19°19′N 41°55′E, 1200 m, BM(NH) 1980.38, WB 12./13.II.1980. – 20: Hakimah (see above), BM(NH) 1979.638-645, JG, RAF, RBF 1.XI.1979; idem, BM(NH), JG 70973, 70975, 70976, 3 ♀♀. – 26: Wadi Sayq, 16°44′N 53°20′E, NSL, BM(NH) 1977.910, MDG 20.VII.1970 (Arnold 1980). – 27: Khadrafi, 16°42′N 53°09′E, BM(NH) 1977.898, MDG 20.VIII.1970 (Arnold 1980). – 28: Salalah, 17°00′N 54°06′E, NSL, BM(NH) 1975.1375–76, TDR 28.VIII.1975 (Arnold, 1980); idem, BM(NH) 1977.25, MDG c. 1977 (Arnold 1980); idem, BM(NH) 1977.886–891, ENA 13.X.1977 (Arnold 1980). – 29: Ain Arzat, 17°01′N 54°17′E, BM(NH) 1976.1382–83, SM, MDG c. 1976 (Arnold 1980). – 29: Khawr Sawli, 17°03′N 54°20′E, BM(NH) 1977.892–93 (Arnold 1980); Jabal Qara (?), BM(NH) 1977.908–09 (Arnold 1980). – 30: Wadi Ayun, 17°15′N 53°53′E, BM(NH) 1977.903–05 (Arnold 1980). – 31: 16 km S of Thamarit, 17°30′N 54°02′E, BM(NH) 1977.894 (Arnold 1980). – 32: Wadi Darbat 17°06′N 54°27′E, BM(NH) 1977.899–902 (Arnold 1980). – 33: Wadi Raykhut, 17°26′N 55°16′E, BM(NH) 1977.895–97 (Arnold 1980); Asir (?), BM(NH) 1979.648, JLB. – 20: Hakimah (see above), BM(NH) 1979.683, JG, RAF, RBF 1.XI.1979; Wadi Hali (?), BM(NH) 1964.59, DVF I.1946. – 34: Diq Duqqah, 25°40′N 55°58′E, 1460 m, BM(NH) 1973.1781–86, ENA 26.V.1973. – 35: Masafi, 25°18′N 56°10′E, 400 m, BM(NH) 1973.1787–88, ENA 22.III.1971. – 28: Salalah (see aobve), BM(NH) 1974.4015–16, BM(NH) 1975.1377, BM(NH) 1977.906–07, BM(NH) 1978.979. – 36: Wadi dhu Mayhi, 20°29′N 58°55′E, 60 m, BM(NH) 1975.1031, TDR 25.IX.1974. – 37: Khasab, 26°11′N 56°15′E, 30 m, BM(NH) 1976.1379, MDG 2.IX.1976. – 38: Wadi Haql, 20°22′N 56°15′E, 150 m, BM(NH) 1976.1380–81, MDG 20.X.1976. – 39: Jammah, 23°33′N 57°31′E, 300 m, BM(NH) 1977.771–72, MDG 17.VI.1977. – 40: Batinah, 23°45′N 57°20′E, 75 m, BM(NH) 1977.773–75, MDG 6.VII.1977. – 37: Wadi al Jamat, 26°09′N 56°17′E, 150 m, BM(NH) 1978.2034–35, MDG 3.III.1979. – 20: Hakimah (see above), BM(NH) 1980.97, JG 1.XI.1979. – 41: Al Muqf, 19°58′N 57°20′E, 150 m, BM(NH) 1980.1036, MDG c. 1979. – 42: AL Bahra, 21°29′N 39°30′E, 100 m, BM(NH) 1982.232, WB 12.VI.1978. – 43: Farasan al Kabir, 16°42′N 41°59′E, NSL, MZUF 1984.19.15576–79, BL 12.IV.1984.

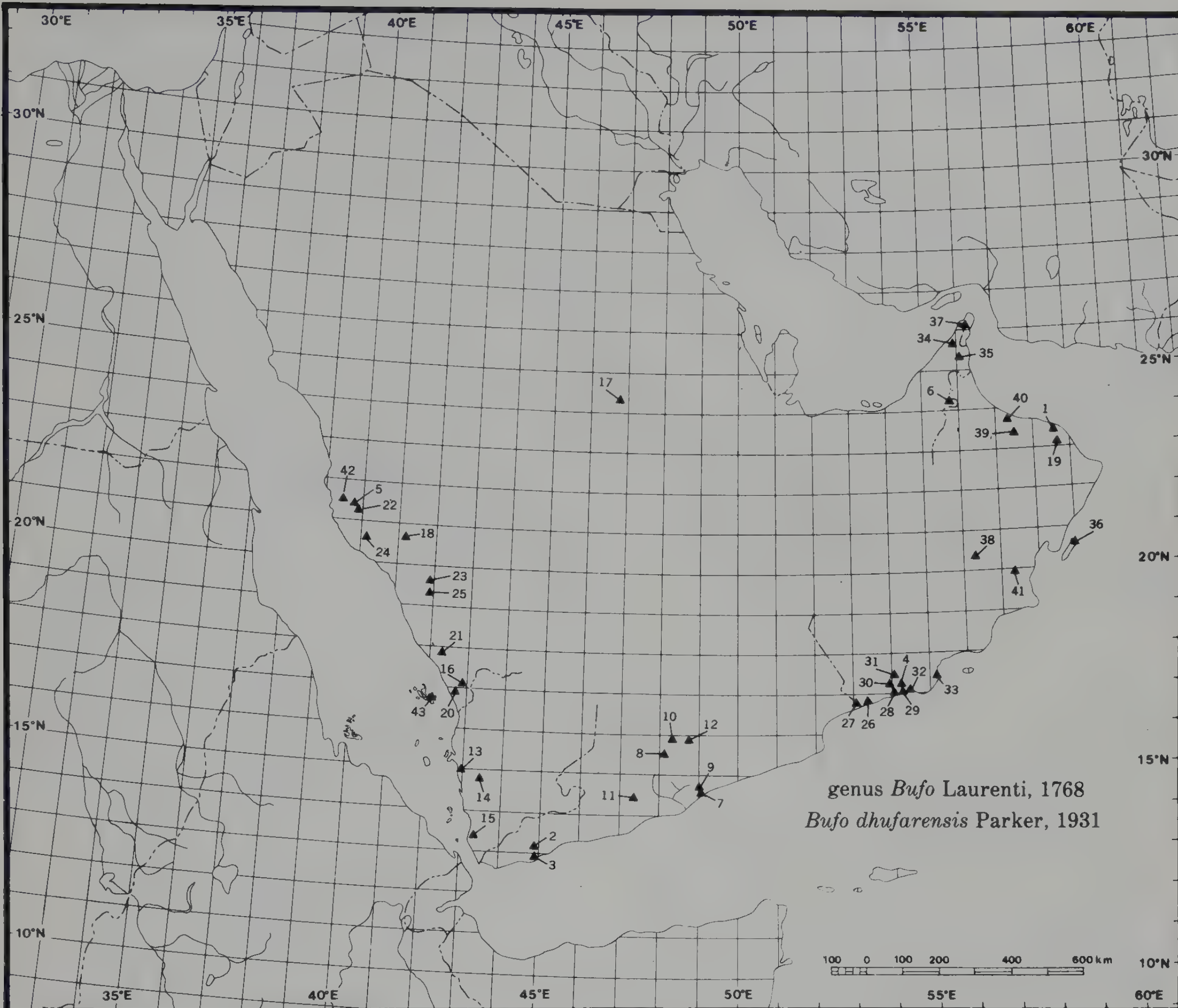


Fig. 5: Distribution of *Bufo dhufarensis.*

Description: A small sized species of *Bufo*, up to 65 mm long from snout to urostyle. Dorsal parts uniform reddish-brown, occasionally marked with irregular, small dots of a darker colour. Limbs occasionally more or less faintly banded. Underside yellowish-white. Dorsal skin smooth or dotted with small, indistinct warts, each bearing a single central spine. Dorsolateral flaps strongly pronounced, running from the shoulder to the groin ([1]). Head moderate, its length being 74% of its width and about 25% the total length of the body. Snout strongly projecting forward from the mandible, truncate in dorsal view; obliquely sloping behind, in lateral view. Nostrils set at the sides of the snout, level with its tip, the internarial distance is about 61% of interorbital space. Width of the upper eyelids equal or slightly smaller than that of the interorbital space. A cross fold running behind the upper eyelids joins the centers of the upper edges of the tympana. Parotoid glands often scarcely distinct, reniform, and of greatly variable size (8–20% of body length). Tympanum very distinct and large, oval, its larger (vertical) diameter is 70–80% of the horizontal eye diameter, set very close to the eye and separated from it by the mere width of the lower eyelid. The distance from the nostril to the anterior corner of the eye

([1]) Specimens not previously fixed in formalin may have a tendency to swell in alcohol obscuring the dorsolateral flaps.

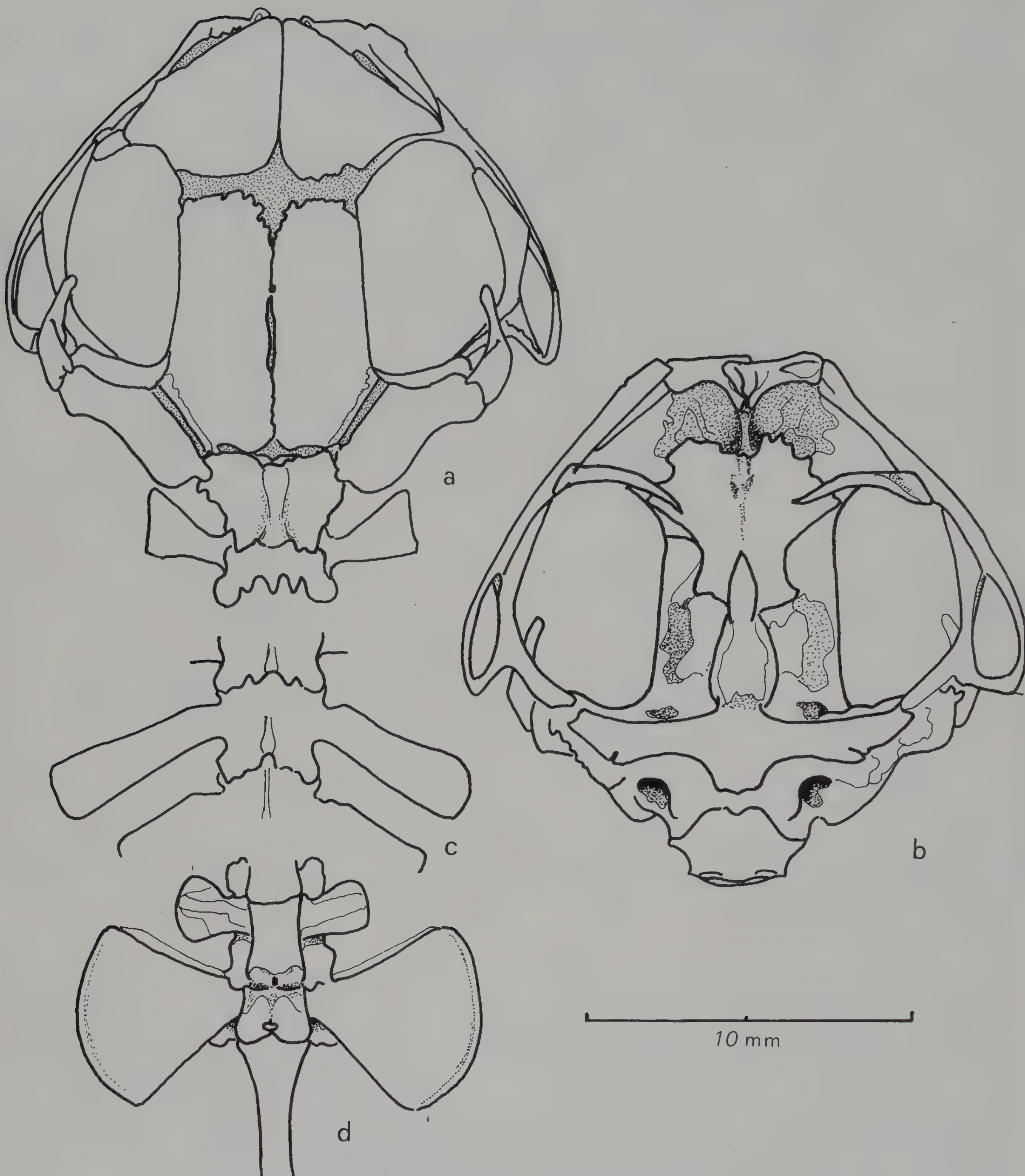


Fig. 6: Skeletal feature of *Bufo dhufarensis* from Dis, ♀ (IZUG). a, Dorsal and b, ventral views of skull. c, 3rd vertebra from dorsal view. d, 7th and 8th (sacral) vertebrae from ventral view.

is about 71% of the horizontal diameter of the eye. Males with a single, internal black pigmented vocal sac, easily seen through the gular teguments.

Fore limb rather slender, hand moderate, fingers comparatively thick. Subarticular tubercles simple, prominent; two rather prominent palmar tubercles; finger tips slightly swollen, keratinised. A glandular ridge runs from the corner of the mouth to under the lateral fold, reaching it in the region below

and behind the parotoid glands. Hind limb short, from urostyle to the tibio-tarsal joint it equals about 72% of the body length, extended forward along the body the tibio-tarsal articulation reaches the axillar region or the shoulder. Tarsus 32% of the hind limb; with a thin, but distinct, glandular tarsal ridge. Foot about 58% as long as the hind-limb to tibio-tarsal articulation, webbed to ⅔ of the first phalange of the fourth toe; metatarsal tubercles small, the inner one about 10–13% of the foot length.

The skull of *Bufo dhufarensis* (fig. 6) is rather elongate and shallow; its maximum width measures 1.15 times its length; its height is 36% of the length. The ratio of depth to width of braincase is 0.55. Frontoparietal bones completely smooth, forming a tight suture in the middle; sphenethmoid completely exposed between the nasal and the frontoparietal bones, in dorsal view. Canal of occipital artery is exposed its entire length. Dorsal otic plate of the squamosal bone overlapping the prootic by about ½ its length; the latter is completely fused with the frontoparietal. Quadratojugal overlapping the posterior part of the maxilla in the anterior half of the pterygoid fenestra. Intrapterygoid angle smaller than the pterygoid-parasphenoid angle when the skull is viewed from the rear; no transverse parasphenoid ridge. Palatines smooth. Vertebral column anteriorly moderately wide, tapering strongly caudally, The length of the transverse processes of the 3rd vertebra equals 94% of the skull length; that of the transverse processes of the 7th vertebra is 47% of the 3rd. The diapophyses of the 8th (sacral) vertebra are equal to 42% of the length of the skull. A single, median, vertebral crest is formed by the dorsal neural spines.

The skeleton of *Bufo dhufarensis* differs from that of *Bufo scorteccii* by having a comparatively longer and narrower skull. The braincase of *Bufo scorteccii* is also much deeper and its frontoparietal bones are separated by a more or less parallel-sided gap, rather than forming a tight suture. Some additional features are visible in figs 6 and 12, and in tab. 1.

Variation: Males are promptly identified by their dark gular sac, which is clearly visible through the gular skin. Breeding males also show some keratinisation of the inner parts of the first and second finger and of the rear side of the inner palmar tubercle.

Size differences between sexes are not great; males measure 45–54 mm from snout to urostyle (average 51.1 ± 3.1 S.E.M.), the females 47–65 mm (53.8 ± 4.6). Females also have a slightly larger head, its length is about 74% ( ±0.16) of its width (72.4% ± 0.15 in males) and 26% (± 0.02) of the total length (25% ± 0.01 in males). A series of biometrical measurements are reported in a previous paper (Balletto & Cherchi 1970).

Tadpole: Twenty nine larvae of *Bufo dhufarensis* (fig. 7) were collected by Prof. G. Scortecci at Gedda, 16°01'N 48°51'E, 760 m, 15.IV.1962; 108 more were brought from Al-Ghurfah 15°54'N 48°44'E, 600 m, collected 13./14.IV.1962. The specimens from Gedda measured 12.5–24 mm. From the snout to the tip of the tail, all of them were legless. Tadpoles from Al-Ghurfah were more variable in length, 12–43 mm long and several of them (30.3–43 mm) were two- or four-legged (stages 38–42). The largest specimen was two-legged (stage 40). Colour in alcohol is dark reddish-brown, on the upperside, the muscular part of the tail, and the sides and rear parts of the belly. The upper caudal membrane is speckled with the same colour; the lower membrane is colourless. Nostrils are set closer to the eye than to the snout, the internarial space is smaller than the interorbital. The eyes are large, set on the upper surface of the head in the first third of the body, their distance to the snout is about two-thirds of their distance to the spiracle. The spiracle is ventro-lateral, on the left side of the body, scarcely or not visible in dorsal view, set at about 60% of the total body length, and directed backwards and slightly upwards. The body length is 41–47% of the total length. The anus is median. The tail is obtusely tipped, the upper caudal membrane only slightly convex, about as deep as the lower membrane. It extends along the body to about the same level as the spiraculum. Larval mouth is framed by a more or less double series of papillae at the mouth corners. Rostrodonts are comparatively long and not very strong-

9a

9b

9c

9d

Plates 9 a–d: *Bufo dhufarensis.*

ly sclerotised, finely toothed in the middle. Keratodonts are set in five rows: a continuous one and a rather widely interrupted one on the upper lip, and three continuous rows on the lower lip. Keratodonts under strong magnification show the normal flat and fringed tip structure that is found in most species of *Bufo.*

Systematics: *Bufo dhufarensis* was described by PARKER (1931) from a single female specimen from Milwah Al Aud in Dhufar. The author pointed out that this species is morphologically similar to *Bufo dodsoni* Boulenger, 1895, from Somalia. DUBOIS (1974) in an extensive survey of this group of toads, based both on historical and morphological grounds, suggested that *Bufo dhufarensis* might represent a junior synonym of *Bufo stomaticus* Lütken, 1863, from SW Asia and India (type locality East India, restricted to Assam by BOULENGER (1890).

Other synonyms of this species might be represented by *Bufo olivaceus* Blanford, 1874 (type locality: River Dasht: Gedrosia, in Baluchistan) and possibly *Bufo oblongus* Nikolsky, 1896 (type locality: Ssman Shahi Mts, surr. of Biryand, E. Iran). DUBOIS' opinion, however, was not shared by EISELT & SCHMIDTLER (1973) who noted several characters allowing the distinction of *Bufo stomaticus* from *Bufo olivaceus* and considered *Bufo oblongus* as a subspecies of *Bufo viridis.*

INGER (1972) treating the systematic and phylogenetic relationships among the Eurasian species of *Bufo,* included *Bufo dodsoni* in the group of *Bufo orientalis*, and referred *Bufo stomaticus*, *Bufo olivaceus*, *Bufo dhufarensis* and *Bufo beddomi* to the distinct, though closely related, group of *Bufo stomaticus.* The main differences between these groups would be the presence (in the"*stomaticus* group") or absence (in the "*orientalis* group") of a dorsal otic plate of the squamosal bone, and by the slightly broader seventh transverse process of the vertebral column, in the "*orientalis* group". Among the species of the "*stomaticus* group", those that are of immediate concern for the purposes of the present paper are, of course, *Bufo dhufarensis,* on the one hand, and *Bufo stomaticus* and *Bufo olivaceus,* on the other.

From the osteological point of view, they are said to differ in that *Bufo dhufarensis* would have larger transverse processes on its third vertebra, the ratio width of 3rd process/skull-length being 1.06–1.20 instead of 0.91–1.06 as in *Bufo stomaticus* (INGER 1972). Morphological differences between the two species are more definite. *Bufo dhufarensis* has very large dorsolateral folds; brown, rather than blackish finger and toe-tips; a shorter head (about 25% body length rather than 35–43%); a wider internarial space (about 61% of interorbital space rather than 65–80%); a true tarsal fold, instead of a series of longitudinally arranged tubercles, on the inner edge of the tarsometatarsal segment. *Bufo stomaticus* is, on average, a much more "spiny" species than *Bufo dhufarensis* and always has at least a few spiny tubercles on the fore edge of the tympanum, behind the eye, and another small such row immediately before the anterior eye-corner. Apart from the spinose characters of *Bufo stomaticus,* the same features noted above can be used to distinguish *Bufo dhufarensis* from *Bufo olivaceus* Blanford. Although no osteological characters were reported by INGER (1972) to support separation of the latter from *Bufo stomaticus,* some biometrical features were reported by EISELT & SCHMIDTLER (1973). These are mainly represented by the smaller and often scarcely defined parotoid glands of *Bufo stomaticus* (length of parotoid gland/length of the upper eyelid: 1.9–**2.3**–2.6 rather than 2.4–**3.1**–3.9: 1. p.g./body length: 0.21–**0.24**–0.31, rather than 0.30–**0.41**–0.47, as in *Bufo olivaceus*). These differences correspond with our observations on a score of specimens of *Bufo stomaticus* from various localities from India and Pakistan [these comprising the type specimens of *Bufo andersonii* Boulenger, 1883 ([2]), and the type-series of *Bufo olivaceus* ([3])].

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([2]) Lectotype herewith designated: BM(NH) 83.11.26.105, ♀, from Tatta (Bombay: India), 24°44'N 67°58'E.
([3]) Lectotype herewith designated: BM(NH) 74.11.23.122, ♂, from Dasht (Baluchistan), W.T. Blanford leg.

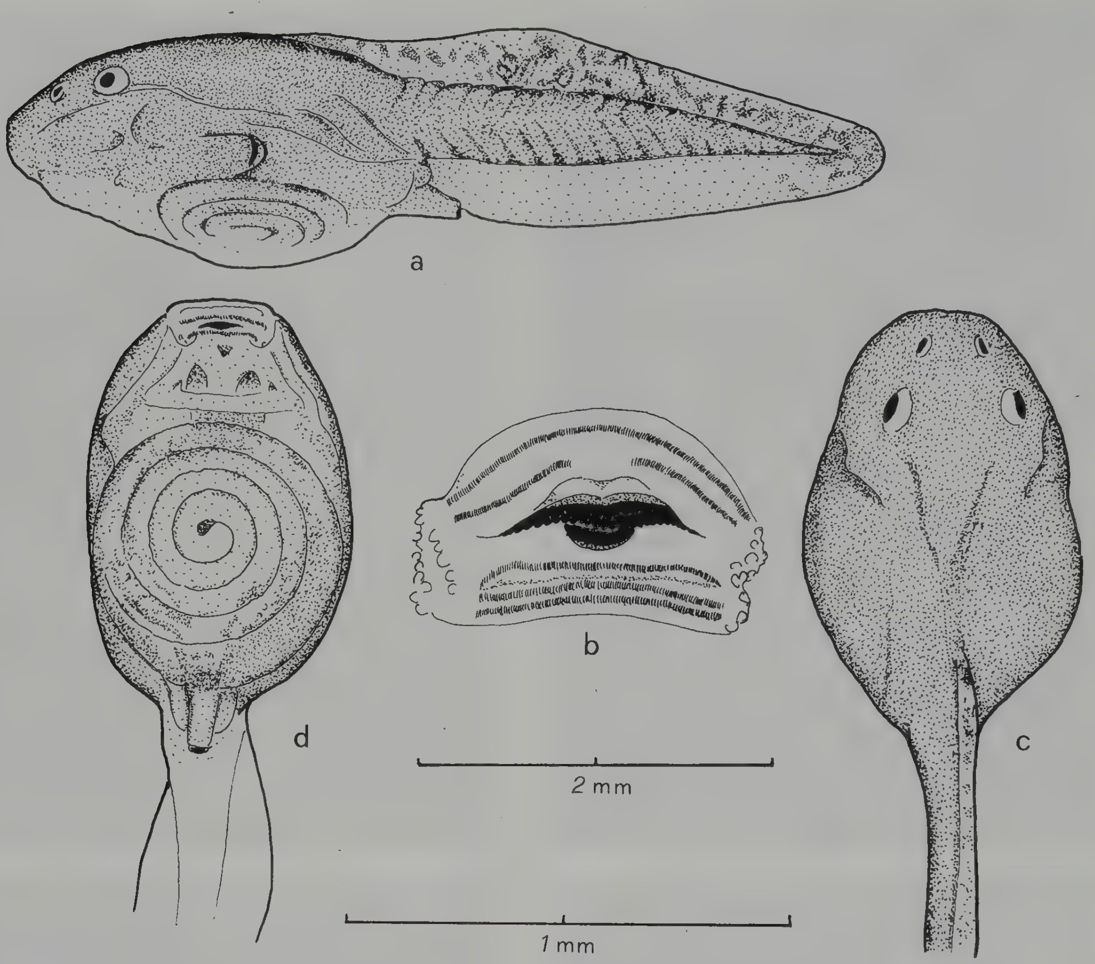


Fig. 7: Tadpole of *Bufo dhufarensis* from Al Ghurfah, collected 13.IV.1962 (IZUG). a, Lateral view of tadpole. b, Larval mouth. c, Dorsal and d, ventral views of tadpole.

Reported differences in dorsal patterns (brownish, marbled darker, in *Bufo stomaticus* and uniform light greyish-brown in *Bufo olivaceus*) proved, instead, to be largely encompassed by local and individual variations in *Bufo stomaticus*. We did not have an adequate series of *Bufo olivaceus*, however, it might be that it represents an extreme variation of *Bufo stomaticus*, as suggested by Dubois (1974).

As to the species of Inger's (1972) "*orientalis* group" (*Bufo orientalis*, *Bufo dodsoni*), they can be distinguished, osteologically, by the presence of an otic plate on the squamosal bone, which is missing in species of the "*stomaticus* group". This character is obvious in both alizarin-stained specimens or in dry skeletons. Morphological differences between *Bufo dhufarensis* and *Bufo dodsoni* (from East Africa) are the following: *Bufo dodsoni* has more constantly warted dorsal parts, particulary in males, with multispinose tubercles; much less pronounced dorsolateral folds; slenderer fingers; and a white, rather than black, gular sac in breeding males.

By contrast, morphometric differences between the two species are slight. A biometrical analysis carried out on 221 specimens of *Bufo dodsoni* from Somalia and 77 *Bufo dhufarensis*, showed that they are comparable to those existing between populations of *Bufo dodsoni*. Biometrical features of *Bufo dhufarensis* are, surprisingly enough, more similar to those of *Bufo dodsoni* from southern Somalia than to the nearer populations of *Bufo dodsoni* from northern Somalia (unpublished results of M. A. Cherchi).

Ecology: *Bufo dhufarensis* is encountered in arid environments. During aestivation it burrows very deep into the ground, and emerges only for a short time after rains. At Ingrams (Wadi Hadramawt) these toads were collected in large numbers from a pond that formed during a sudden storm where two days before there was only dry sandy soil. The activity pattern of *Bufo dhufarensis* is almost exclusively nocturnal. Diurnally, even during the few "wet" periods of the year, they seek shelter in rock crevices and under boulders or sometimes in burrows as deep as 30 cm or more. In the Farasan Kabir Island they were found under large stones in an environment where there was apparently no water at all, except after some sparse rain.

At km 126.5 on the Makkah by-pass 1 km south of the road there is a small basin where flood waters from a wadi, with a relatively small (20 $km^2$) drainage area, is entrapped after rains. Annually there is some water, as a result of something on the order of 100 mm per annum of rainfall, as an average. On the night of 24.X.1979 there was a torrential rain in the immediate vicinity. The catchment area, about 200 m upstream-downstream and 50 m wide was filled. The following morning, 25.X.1979, there were 100–200 pairs of *Bufo dhufarensis* calling and pairing in great confusion. Probably, had the episodic rainfall taken place at any other time of the year, the toads would have reacted in the same fashion, i.e., from aestivation to hectic breeding activity when there is rainfall, regardless of the time of year with the chance that the wet conditions will persist through the period of egg incubation and development of the larvae from tadpoles to toads. At Wadi Kharrar (21°17'N 40°06'E, 460 m) larvae in various stages of development have been seen dead or dying, in drying, miniscule pools of water resulting from the last rain. If it would rain again their life cycle could continue. Those that are able to go into aestivation will emerge following the next rainfall.

A peculiar observation: When Wadi Kharrar (or the catchment at km 126.5 on the Makkah bypass) is dry, the predators of *Bufo* such as various species of snakes are in aestivation and various species of birds and carnivores are absent. *Bufo* sp. then has a valuable time factor (particularly vis-à-vis the avian and mammal predators) for conduct of their propagation activities immediately following a rain and before their predators opportunistically return to the area of recent rainfall.

### ***Bufo viridis*** Laurenti, 1768

*Bufo viridis* Laurenti, 1768: 27, pl.1, fig. 1. Type locality: Wien; by selection by Mertens & Müller (1928: 18).
*Bufo viridis* Laurenti - Boulenger 1882a: 297; Barbour 1914: 78; Schmidt 1941: 161; Balletto & Cherchi 1971: 36; Arnold 1980: 276.

Type material: not traced.

Other material (47 specimens, see map, fig. 2): "Dead Sea", 31–32°N 35°30'E, BM(NH) 64.8.23.98–100, 10, 1 ♀ 1 ♂ 1 juv., HBT. – Mt. Carmel, 32°45'N 35°02'E, BM(NH) 64.8.24.70, ♀, HBT. – "Sinaitic Peninsula" (?), BM(NH) 84.6.18.16, ♀, HBH. – Wadi al Gederiat (Sinai) (?), BM(NH) 1918.12.14.2–4, SF. – El Arish, 31°07'N 33°51'E, CNHM 58724–25, 58892–93, HF (Schmidt & Marx 1956)[5]. – Abu Aweiqileh, 30°50'N 34°07'E, CNHM 58726–886, 58894, HF (Schmidt & Marx 1956)[5]. – 1: Petra, 30°20'N 35°26'E, 1000 m, 11 spcs, JCP, WMM (Barbour 1914)[5]. – 2: Hail, 27°33'N 41°42'E, 980 m, CNHM 31655, 3 spcs, HStJBP (Schmidt 1941)[5]. – 3: Hulaifah, 26°00'N 40°47'E, 870 m, CNHM 31655a, 3 spcs, HStJBP (Schmidt 1941)[5]. – 4: Taif, 21°16'N 40°24'E, 1600 m, BM(NH) 1935.2.1.1–4, HStJBP. – 5: Dor, 18°16'N 42°24'E, 2900 m, BM(NH) 1977.384–392, CHL. – 6: Bani Mashoor, 19°00'N 42°09'E, 2300 m, BM(NH) 1980.98–103, BM(NH) 1979.684–690, JG, MVA 6./7.VI.1979; idem, BM(NH) 1980.306–309, RAF 3.X.1979; idem, IZUG JG 72523–526, 3 ♀♀ 1 ♂, JPG 1.IV.1980;

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([5]) This footnote, which indicates specimens previously reported but not examined by the present authors is explained in the introduction.

idem, BM(NH) JG 70964, WB, GV VII. 1980. – 7: Al Khadra, 19°19'N 42°05'E, 2800 m, IZUG JG 72790, 2 juv., AKN 12.VIII.1980. – 8: An Nimas, 19°07'N 42°08'E, 2250 m, BM(NH) 1979.690, AKN 3.XI.1979; idem BM(NH) 1982.240, WB VI.1980.

Description: Arabian *Bufo viridis* is a middle-sized toad, up to 78 mm long from snout to urostyle, characterised by a stout habit, particularly in the females. Colour of dorsal parts is more or less light grey, extensively marbled with rather large elongated, green or olive-green spots, occasionally fusing with each other to appear as a reticulated pattern. A couple of green stripes extend from the nostrils to the eye; a green spot on the upper lip under the eye (practically always preceded by a smaller one placed midway to the snout tip); a couple of green cross bars on the upper eyelids, running backwards along the inner edges of the parotoid glands, represent the most constant features of the dorsal pattern. On the back, the size, shape and number of green markings are extremely variable among individuals. Some specimens may have a more or less continuous vertebral white line, or a grey longitudinal interval between the two sets of dorsal marbling. A series of cross bars on dorsal parts of the limbs. Normally a round (solid or hollow) or Y shaped dot on the tibia. Ventral parts of the body and limbs solid creamy-white. Dorsal skin granulose, with the presence of many, normally large, prominent warts, flattened or hemispherical in shape, each of them smooth above or bearing one or many small spines. Ventral skin granulose. A couple of interrupted laterodorsal glandular ridges, running from behind the mouth corners to the groin. A well defined, flat, continuous ulnar ridge, and a similar, but more prominent, sharp edged tarsal fold.

Head moderate, 70–74% as long as broad and about 26% as long as the whole body; snout not projecting beyond the mandible, obtusely pointed in dorsal view and sloping down in a rather continuous curve, when seen from the side. Canthus rostralis clearly marked, obtuse, lores concave. Nostrils set laterally behind the tip of the snout, the internarial distance being practically equal to the width of interorbital space (i.n.d./w.i.s. 0.8–1.1); the latter is 60–75% of the width of the upper eyelid. Tympanum rather small, vertically elliptical, its maximum diameter is 43–57% of the horizontal diameter of eye; the minimum distance between the two organs is 30–55% of the maximum diameter of tympanum. The distance between nostrils and the snout tip is 40–52% of the distance from nostrils to the anterior eye corner and 53–64% of the horizontal diameter of eye. Parotoid glands rather prominent, extending laterally behind the tympanum and often covering its posterior edge, particularly in females. Their length measures 22–26% of total body length. Males with an internal vocal sac surrounded by more or less black pigmented muscles, occasionally showing through the gular skin.

Limbs rather thick and short. Hand middle sized, fingers very thick. The first finger, measured at base, is 42–58% of its length. First finger is longer than the second, 40–54% as long as the entire hand and 80–110% as long as the horizontal diameter of eye. Subarticular tubercles prominent, single or slightly doubled; palmar tubercles rather prominent. Hind limb rather short, 61–69% as long as the body length, when measured to tibio-tarsal articulation; when extended forward along the body the point of tibio-tarsal articulation reaches the axilla or the shoulder, in females, or between the shoulder and the tympanum, in males. Tarsus 32–36% as long as tibia and femur. Foot 56–70% of the tarsus, webbed to the basal third of the first phalange of fourth finger which is 53–59% of foot length. Inner metatarsal tubercle inconspicuous, flattened, 11–14% as long as the foot.

Variation: Sexual dimorphism is rather obvious. Males can be recognised by their extended single keratinisation on the mesial side of the first finger, slenderer habit and smaller size. The examination of the internal vocal sac requires dissection. Males measure 48–66 mm in length, females 53–78 mm.

Tadpoles:Tadpoles of Arabian populations of *Bufo viridis* have not been collected. Nothing is known of the population biology of this species.

Ecology: The Arabian populations of *Bufo viridis* appear to be very localised relict populations,

well scattered geographically, BARBOUR (1914) noted 3 specimens from Petra; SCHMIDT (1941) reported 3 specimens from Hail and 3 from Hulaifa. The specimens from Hail and Hulaifa should probably be re-examined before further comment. Petra is considered to be the southern extent of the distribution of several Palaeartic faunal forms. The two presently certain localities of *Bufo viridis* in Arabia (Sawdah and An Nimas) coincide with the distributional range of other Palearctic (and Ethiopian) relict faunal forms, most notable the magpie, *Pica pica asirensis* Bates, as well as the snake *Eirenis coronella fennelli* Arnold, the white-toothed shrew *Crocidura russula* Herman, and, seemingly restricted populations of *Rana ridibunda*, *Bufo viridis* and *Hyla savignyi* which are also, no doubt, Palaearctic relicts.

*Bufo viridis* was found by C.H. Lowe near Jabal Sawdah at near 3000 m elevation (Arnold, pers. comm.) and by Prof. W. Büttiker, Dr. A. K. Nasher and the junior writer in the vicinity of An Nimas (on separate occasions) at altitudes of 2000–2800 m. These collection sites are in a verdant montane habitat where there are juniper and acacia forests, copses of wild olive trees and other trees and a great variety of other plants and shrubs. This vegetation reflects precipitation on the order of 800 mm per year. Annual temperature extremes range from near zero to 38°C. There are pools of perennial water. Even in the cooler weather in these habitats, *Bufo viridis* is nocturnal (some of Lowe's specimens were found dead on the road at night), sheltering under rocks and in burrows by day. These relicts probably derive from the Würm glaciation.

Hail and Hulaifa while being much further north are at lower elevations (c. 1000 and 900 m, respectively) where the perennial waters are associated with date palm and garden produce irrigation, in a much more desertic surrounding. *Bufo viridis* in this habitat would represent definite relict colonies. It is possible that SCHMIDT (1941) might have confused *Bufo arabicus* with *Bufo viridis* as both are extremely variable and some individuals of either species resemble the other. However, it is more likely that the specimens in question, as well as the specimen BM(NH) 1982.240 from Taif, all of which were collected by Abdullah H.St.J.B. Philby, may have been mislabelled. Philby was an excellent field astronomer and mapmaker. However, several instances of his herpetological collections cast some doubt on his system of labelling and reporting (Arnold, pers. comm.) For instance, *Rana ridibunda* "Rub al Khali Desert". Anyone who has collected such specimens "opportunistically" can easily understand the problem. However, we do not rule out the possibility of isolated populations of *Bufo viridis* as well as other species.

### ***Bufo arabicus*** Heyden, 1827

*Bufo arabicus* Heyden, 1827: 20, pl. 5, fig. 2. Type locality: "Das petraeische Arabien".
*Bufo vulagaris* Laurenti, 1768. – Günther 1878: 977.
*Bufo regularis* Reuss, 1834: 60. – Boulenger 1882a: 298; Steindachner 1900: 335; Barbour 1914: 79; Parker 1938: 491; Balletto & Cherchi 1971: 29; Arnold 1980: 276.
*Bufo pantherinus* Duméril & Bibron, 1841: 664, 687. – Duméril & Bibron 1841: 687, 689; Günther 1878, app. iv.
*Bufo viridis* Laurenti var. *orientalis* Werner, 1896: 20. – Parker 1938: 491.
*Bufo orientalis,* Werner. – Parker 1941: 6; Schmidt 1953: 255; Haas & Battersby 1959: 198; Cherchi 1963: 9; Balletto & Cherchi 1971: 29; Arnold & Gallagher 1977: 70; Arnold 1980: 276.
*Bufo andersonii,* Boulenger, 1883: 163. – Boulenger 1887: 408; Anderson 1895: 662, pl. 37, figs 3, 3a (tadpole); Parker 1938: 491, 492.

Holotype: SMF 3630, ♀, "das petraische Arabien", E. Rüppell leg. (HEYDEN 1827).

Other material (894 specimens, 276 larvae and eggs; see map, fig. 8): 1: Lahej, 13°04'N 44°53'E, 150 m, 2 juv. 1 larva, JWY c. 1895 (ANDERSON 1895)[5]; Lahadsch (= idem), ON XI.1892 (MATSCHIE 1893)[5].– 2: Muscat, 23°37'N 58°35'E, BM(NH) 1885.11.7.30–32, 34, ♀♀, ASGJ (BOULENGER 1887); idem, JB 1893/1894 (WERNER 1896)[5]; idem, BM(NH) 1891.2.9.50–53, ♀♀, ASGJ; idem, BM(NH) 1895.11.1.2–3, ♂♂; idem, BM(NH) 1880.11.10.104; idem BM(NH) 1976.1394, MDG 12.IX.1976.– 3: Sheikh Othman, 12°42'N 44°59'E, NSL, BM(NH), ABP (ANDERSON 1901). – 4: Midyan, 27°40'N

35°30′E, BM(NH) 1878.9.26.4, RJB (Günther 1878). – 5: nr Mecca, 21°27′N 39°49′E, 270 m, 7 spcs, AB 30.I.1898 (Steindachner 1900)[5]. – 7: Najran, 17°30′N 44°07′E, 1340 m, BM(NH) 1938.2.1.98–104, HStJBP 5.VII.1936 (Parker 1938); idem, BM(NH) 1963.813, GBP 19.VII.1962; idem, BM(NH) 1985.427–430, 1 ♂ 2 ♀♀ 1 juv., JLB 20.IX.1983. – 8: Sail (= As Sayl al Kabir), 21°39′N 40°24′E, 1220 m, HStJBP 12.V.1936 (Parker 1938); S Hejaz (?), BM(NH) 1938.2.1.107-113, HStJBP (Parker 1938). – 9: El Kubar, 13°48′N 44°45′E, 1350 m, BM(NH) 1903.6.26.55–56, GWB (Parker 1938). – 10: Azraki Ravine, 13°22′N 44°39′E, 550 m, BM(NH) 1903.1.28.20, GWB. – 11: Taif, 21°16′N 40°24′E, 1600 m, BM(NH) 1934.10.20.1–3, BM(NH) 1935.10.8.1–12, HStJPB; idem, BM(NH) 1976.1707–1708, GBP 22./24.VI.1962. – 12: Taizz, 13°34′N 44°02′E, 1370 m, HH, REK (Schmidt 1953)[5]. – 12: Al Amra, 13°34′N 44°02′E, HH, REK (Schmidt 1953)[5]. – 13: 48 km E Ubal, 15°00′N 44°00′E, 1500 m, HH, REK (Schmidt 1953)[5]. – 13: Wadi Siham, 15°00′N 44°09′E, HH, REK (Schmidt 1953)[5]. – 14: 8 km W of Mabar, 14°48′N 44°17′E, 2400 m, HH, REK (Schmidt 1953)[5]. – 14: Wadi Mal al Ghayl, 14°48′N 44°10′E, 2400 m, HH, REK (Schmidt 1953)[5]. – 15: Sana, 15°21′N 44°12′E, 2400 m, HH, REK (Schmidt 1953)[5]; idem, BM(NH) 1980.183–184, AES; idem, IZUG, 13 ♀♀ 1 ♂ 2 juv. c. 50 larvae & eggs, GS IX.1965. – 15: Migyal al Asad Stet, 15°17′N 44°21′E, 2500 m, BM(NH) 1938.8.1.4–9, EBB 18.III.1938 (Parker 1941). – 16: Wadi Ahwar, 13°39′N 46°38′E, 1980 m, BM(NH) 1953.1.6.56–64, GBP 1950/1953 (Haas & Battersby 1959). – 17: nr Jiddah (?), 21°30′N 39°12′E, NSL, CAS 139738, JG VIII.1974. – 18: Wadi Buwwah, 20°46′N 41°12′E, 1400 m, CAS 139736–37, JG 23.IX.1974. – 19: Abu Hawariq, 20°16′N 40°23′E, 150 m, CAS 119215, JG 28.X.1968. – 7: Abu Said, 17°29′N 44°08′E, 1350 m, CAS 119224–225, JG 30.XI.1968. – 7: Al Hussayn 17°28′N 44°09′E, 1350 m, CAS 119228–32, JG 2.XII.1968. – 20: Wadi Saiq, 23°04′N 57°38′E, 1980 m, BM(NH) 1974.945, LP 9.III.1974 (Arnold & Gallagher 1977); idem, BM(NH) 1971.146–148, MDG 20.VIII.1970 (Arnold & Gallagher 1977). – 21: Aqabat al Hamra, 23°09′N 57°20′E, 640 m, BM(NH) 1975.909, DP 17.IV.1975 (Arnold & Gallagher 1977). – 22: Wadi Qid, 23°12′N 58°37′E, 760 m, BM(NH) 1975.894–96, MDG 23.IV.1975 (Arnold & Gallagher 1977) .– 21: An Nid, 23°13′N 57°20′E, 760 m, BM(NH) 1975.893, DLH 7.IV.1975 (Arnold & Gallagher 1977). – 23: Wadi Sahtan, 23°22′N 57°19′E, 760 m, BM(NH) 1975.886–92, MDG 2.IV.1975 (Arnold & Gallagher 1977). – 23: Wadi Rostaq, 23°23′N 57°27′E, 270 m, BM(NH) 1973.699–700, MDG 14.III.1976 (Arnold & Gallagher 1977). – 24: Khaibar 18°48′N 42°52′E, 1700 m, CAS 144202–03, IAN 22.XI.1976; idem, BM(NH) 1963.811–812, GBP 19.V.1962. – 25: 45 km SE of Taif, 20°58′N 40°43′E, 1680 m, BM(NH) 1978.354, JG 4.V.1978. – 26: Wadi Mahra, 19°38′N 41°55′E, 1900 m, BM(NH) 1978.894, HW IX.1978; idem, BM(NH) 1979.646–647, RAF 29.X.1979; idem, BM(NH) 1979.634–635, RAF 29.X.1979. – 27: Majmaa, 22°05′N 40°01′E, 700 m, BM(NH) 1978.2024–27, JG, JWS 27.III.1979; idem, IZUG JG 72825, JG 72827, 7 ♂♂ 6 ♀♀ 3 juv., JPG, SSN. – 28: Makkah by-pass km 126.5, 21°19′N 40°00′E, 300 m, BM(NH) 1979.931, JPG, JJL 26.III.1980; idem, BM(NH) JG 70984–85, AWS 16.I.1981; idem, BM(NH) JG 72587, JPG, PA 16.II.1981. – 28: Makkah by-pass km 124, 21°18′N 39°59′E, 310 m, IZUG JG 72826, 3 ♂♂ 3 ♀♀, JPG 16.XII.1983; idem, BM(NH) JG 72869–870, ♂ ♀, JPG 1.II.1985. – 26: vic. Al Alayyah, 19°37′N 41°59′E, 2200 m, BM(NH) 1979.926–928, JPG 2.IV.1980; idem, BM(NH) 1979.650, WB 9.X.1979. – 29: Bani Mashoor, 19°00′N 42°09′E, 2300 m, BM(NH) JG 72469, JG, MVA 6.VI.1979; idem, IZUG, 3 ♂♂ 1 juv., JG, MVA 1.IV.1980. – 30: Al Lith, 20°09′N 40°17′E, NSL, BM(NH) 1979.930, AAF early 1980. – 11: Wadi Hubaykah, 21°10′N 40°23′E, 1800 m, BM(NH) 1979.929, AAF early 1980. – 31: Wadi Turabah, 20°36′N 41°16′E, 1400 m, BM(NH) 1979.649, WB 7.X.1979. – 19: Wadi Al Lith, 20°15′N 40°26′E, 100 m, BM(NH) JG 72588, JL 5.II.1981. – 32: Sadd Ghuruq, 21°26′N 40°24′E, 1600 m, BM(NH) 1978.891–893, JPG, SBH 17.VIII.1978. – 33: Jabal Barad, 21°08′N 40°13′E, 1900 m, BM(NH) 1978.895–897 JG, BK 5.V.1978. – 34: Wadi Qaragir, 27°45′N 36°15′E, 1200 m, BM(NH) 1979.932–33, AD, ISC 27.II.1979. – 35: Bani Sar, 20°06′N

41°26'E, 2000 m, BM(NH) 1980.305, JG 11.VIII.1980. – 36: Wadi Siji, 24°19'N 56°09'E, 430 m, BM(NH) 1971.141-45, ENA 23.III.1971; idem, BM(NH) 1971.1065-66, MDG 2.II.1970; idem, BM(NH) 1973.1789-96, ENA 30.V.1973; idem, BM(NH) 1972.1131, larva, ENA 30.V.1973. – 37: Wadi Shawkah, 25°06'N 56°01'E, BM(NH) 1971.1052-56, ENA 27.III.1971; idem, BM(NH) 1972.1349, MDG 10.VII.1972. – 38: Masafi, 25°18'N 56°10'E, 400 m, BM(NH) 1971.1057-59, ENA 22.III.1971. – 39: Asimah, 23°01'N 56°08'E, BM(NH) 1971.1060-64, ENA 21.III.1971; idem, BM(NH) 1972.1345-48, larvae, MDG 23.VII.1972; Wadi al Fay (?), 200 m, BM(NH) 1973.385-86, MDG 5.XII.1972; Wadi Meifa (?), BM(NH) 1963.859-860, WAK, W c. 1963. – 40: Wadi Harran, 15°36'N 44°04'E, 2500 m, BM(NH) 1963.814-815, GBP 3.VIII.1962; btwn Marib and Sana (?), BM(NH) 1963.816, GBP ?. – 41: Sharjah, 25°22'N 55°23'E, NSL, BM(NH) 1973.3495-98, ENA 25.XII.1969. – 5: Al Zaher, 21°27'N 39°49'E, 270 m, BM(NH) 1975.2151-52, AAF c. 1974. – 42: Wadi Mayh, 23°25'N 58°35'E, 150 m, BM(NH) 1976.1384-93, MDG 1.XI.1976. – 43: Abha, 18°13'N 42°30'E, 2000 m, BM(NH) 1976.1735-36, AAF 12.IV.1976; idem, BM(NH) 1977.374-378, BM(NH) 1977.380-383, CHL 12.VIII.1977; idem, BM(NH) 1985.469, ♀ & BM(NH) 1985.471-75, 3 ♂♂ 1 ♀ 1 juv., JLB 4./6.IV.1984. – 43: 10 km W Abha, 18°13'N 42°26'E, 2000 m, BM(NH) 1985.468, juv., JLB 3.IV.1984. – 44: Wadi Mahalla, 18°19'N 42°35'E, 1900 m, BM(NH) 1985.406-411, 4 ♂♂ 2 ♀♀ 19 juv., JLB 17.IV.1981; Asir (?), BM(NH) 1977.363-366, CHL c. 1977. – 43: "Waterfall Wadi", 18°14'N 42°24'E, 2500 m, BM(NH) 1977.367-368, CHL c. 1977. – 45: Sawdah, 18°16'N 42°24'E, 2800 m, BM(NH) 1977.371-373, CHL c. 1977; idem (16 mi. SW ?), BM(NH) 1977.369-370, CHL c. 1977; "Saudi Arabia", BM(NH) 1982.233 ?. – 46: Wadir Thar, 17°59'N 44°01'E, 1260 m, BM(NH) 1982.235-238, WB 27.XI.1979. – 46: Talaa, 18°04'N 43°57'E, 1350 m, BM(NH) 1982.234, WB 23.XI.1979. – 20: Alayan nr Saiq, 23°04'N 57°40'E, 1920 m, BM(NH) 1977.26-27, ♂ ♀, MDG 12.III.1977. – 47: nr Sib, 23°41'N 58°11'E, NSL, BM(NH) 1977.776-779, MDG 6.VII.1977. – 48: Dar al Nasara, 27°25'N 36°25'E, 390 m, BM(NH) 1978.1001-02, GBP 1.IV.1947; Ahad Rufayah (nr Abha ?), BM(NH) 1978.1003-04, AKN 11.V.1975; 60 km W Al Shallal (nr Sana ?), BM(NH) 1982.1141, KAB 11.IV.1980. – 49: Ain Aflag, 22°15'N 46°50'E, 550 m, BM(NH) 1983.1495, BM(NH) 1985.412-421, 5 ♀♀ 5 juv., JLB 11.IX.1983. – 50: Wadir Ar Akua, 17°12'N 43°31'E, 1950 m, MZUF 1983/10.14296-303, MB, MP XI.1979; idem, MZUF 1983/10.1247, BL IX.1980. – 50: Wadi Maqsala 17°05'N 43°32'E, 2000 m, MZUF 1983/10.14304-09, 2 ♀♀ 4 juv., MZUF 1983/10.114310-13, 3 ♂♂ 21 larvae, MZUF 1983/10.14326, 33 larvae, MB, MP, BL XI.1979. – 50: Wadi Mahdi, 17°05'N 43°33'E, 1950 m, MZUF 1983/10.14327-47, 21 juv., MB, MP, BL XI.1979; idem, MZUF 1983/10.14348, 6 larvae, MB, MP 10.IX.1980. – 51: Wadi Yeslem, 17°16'N 43°29'E, 1830 m, MZUF 1983/10.14349-51, 2 juv. 4 larvae, MB, MP, BL 4.VIII.1981. – 50: Wadi Magif, 17°05'N 43°33'E, 1950 m, MZUF 1983/10.14352-71, MB, MP 10.IX.1980. – 50: Wadi Itlah, 17°10'N 43°33'E, 1950 m, MZUF 1983/10.374-75, 1 ♂ 1 juv., MB, MP, BL IX.1979, 10.IX.1980. – 50: Ju Amlah, 17°07'N 43°34'E, 1950 m, MZUF 1983/10.14401-42, 6 ♂♂ 3 ♀♀ 33 juv. 8 larvae, MZUF 1983/10.14458-61, 1 ♂ 3 ♀♀, MB, MP, BL IX.1979, IX.1980, VI.1981. – 52: Jabal al Khattarin, 16°44'N 43°49'E, 1980 m, MZUF 1983/10.14462-82, MB VI.1981. – 53: Al Harf, 16°22'N 44°05'E, 1520 m, MZUF 1983/10.14444-47, juvs, MB, MP 5.VI.1981. – 54: Jabal Khazain, 17°01'N 43°37'E, 2000 m, MZUF 1983/10.14456-57, 2 ♂♂, MB, MP 18.VI.1981; btwn Umm Laylah (17°17'N 43°27'E) and Bagim (?), MZUF 1983/10.14488-568, 1 ♂ 80 juv., MB, MP VI.1981. – 50: Jabal Nafah, 17°07'N 43°34'E, 1950 m, MZUF 1983/10.569-614, 18 juv. 1 larva, MB, MP VI.1981. – 55: Amran, 15°38'N 43°55'E, 2300 m, MZUF 1983/10.14994-96, 2 ♂♂ 1 larva, MB 18.II.1984; Wadi Sheba (?), MZUF 1983/10.14246, 40 larvae, MB, MP. – 56: Rasyan, 13°38'N 43°46'E, 650 m, IZUG, 5 ♀♀ 11 ♂♂ 3 juv. & eggs, GS 6.X.1965. – 12: Taiz (see above), IZUG, 19 ♀♀ 5 ♂♂ 1 juv., GS 28.VII./1.VIII.1965. – 57: Hammam Ali, 14°36'N 44°09'E, 1600 m, IZUG, 28 ♀♀ 24 ♂♂ 11 juv., GS 6./8.IX.1965. – 15: Haddah, 15°18'N 44°10'E, 2400

m, IZUG, 2 ♀♀ 3 ♂♂ 8 juv. 80 larvae, GS 5.IX.1965. – 58: Al Barh, 13°37′N 43°42′E, 600 m, IZUG, 1 ♂, GS 2.VIII.1965. – 59: Al Siyani, 13°49′N 44°10′E, IZUG, 13 ♀♀ 6 ♂♂ 4 juv., GS VIII.1965; Wadi Nakalani (?), IZUG, 1 ♀ 1 ♂, GS 12.VIII.1965. – 60: Al Haurat, 14°08′N 44°10′E, 1500 m, IZUG, 1 ♂ 1 ♀, 76 juv. 20 larvae, GS 29.IX.1965. – 61: Medinet al Abid, 14°39′N 43°57′E, 1300 m, IZUG 5 ♀♀ 19 ♂♂ 2 juv., GS VII.1965. – 60: Auadi, 14°07′N 44°13′E, 1700 m, IZUG, 6 ♀♀ 12 ♂♂, GS 30.IX.1965. – 62: Vahren, 13°45′N 44°10′E, 620 m, IZUG, 3 ♂♂ 1 juv., GS sum. 1965. – 63: Wadi al Khalili nr Mafhaq, 15°07′N 43°54′E, 1550 m, IZUG, 2 ♀♀, GS 28.VIII.1965; Wadi Nakar (?), IZUG, 20 ♀♀ 30 ♂♂, GS 18.IX.1965; Wadi Ezone (?), IZUG, 11 ♀♀, GS 27.VIII.1965. – 63: Manakha, 15°03′N 43°45′E, 2400 m, IZUG, 1 ♂ 2 juv., GS 4.VIII.1965. – 64: Wadi Haam, 22°58′N 39°52′E, 300 m, IZUG JG 73001, ♂, CAL 18.II.1984. – 65: 17°30′N 42°56′E, IZUG JG 72824, 3 juv., DL 1984. – 66: Wadi Qust, 20°56′N 41°06′E, 1500 m, IZUG JG 72838, 2 ♀♀, WB 28.II.1984. – 67: Jabal Dabbagh, 27°52′N 35°48′E, 1450 m, IZUG JG 72836–37, 2 ♂♂, EDL, ISC 3.III.1984; idem, IZUG JG 73002, 2 ♂♂ 1 juv., ISC 1985. – 68: Wadi Harraq, 22°49′N 39°22′E, 170 m, IZUG JG 72809, 1 juv., WB 6.V.1983. – 69: Hakimah, 17°01′N 42°50′E, 80 m, BM(NH) 1979.898–900, JPG 1975. – 70: Wadi Arran, 22°00′N 39°34′E, 150 m, IZUG JG 72835, 1 juv., WB 4.X.1983. – 71: 7 km S of Al Qaraah, 18°00′N 42°42′E,

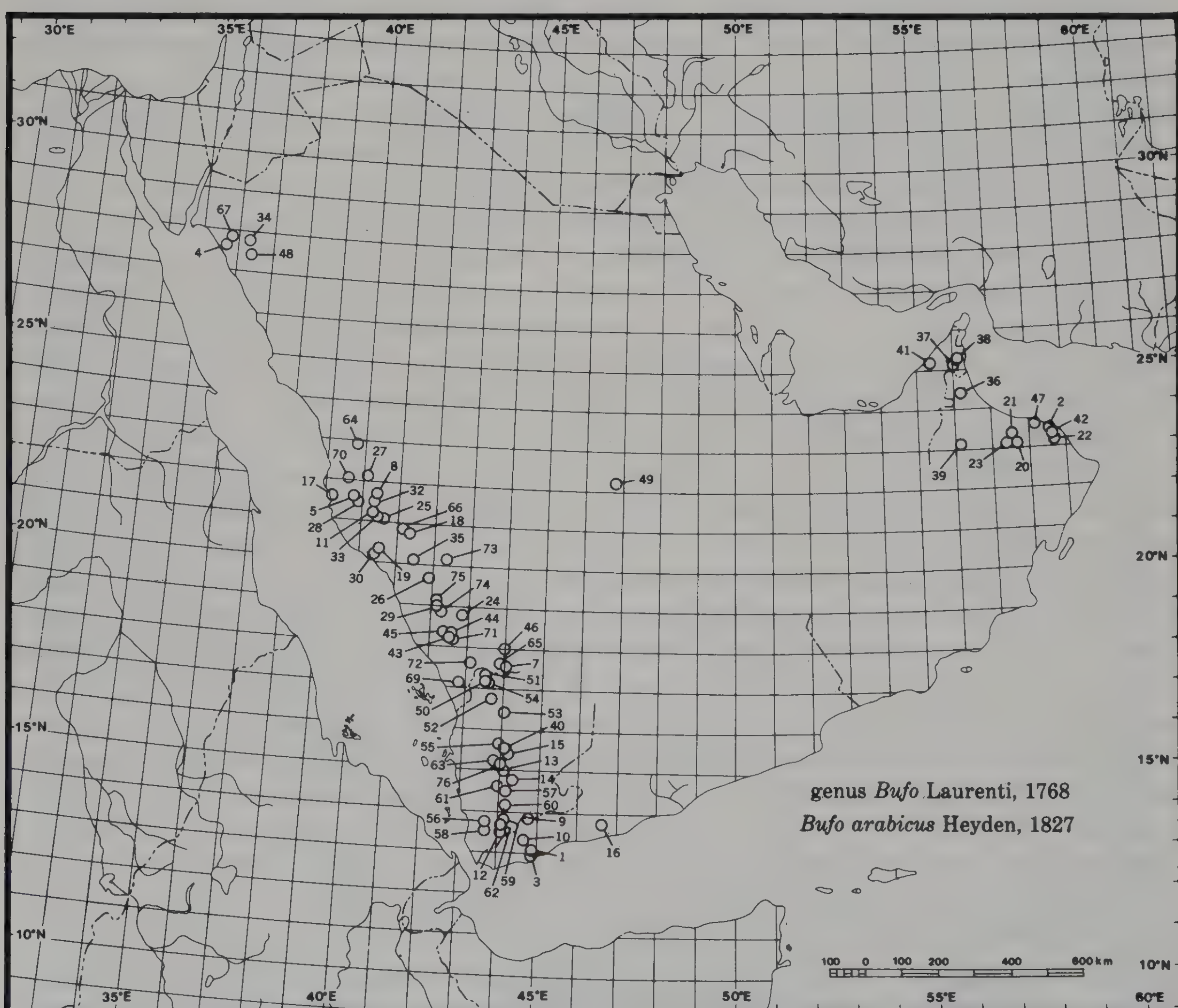



Fig. 8: Distribution of *Bufo arabicus*.

2200 m, IZUG JG 72831, ♂, AKN, 11.XI.1983. – 72: 17°27′N 43°07′E, IZUG JG 72823, 1 ♂ 2 juv., DL 1984. – 71: Wadi Jeman 34 km SE of Abha, 18°04′N 42°45′E, 2200 m, BM(NH) 1985.470, juv., JLB 4.IV.1984. – 73: Bisha, 20°10′N 42°40′E, 1100 m, BM(NH) 1985.431–34, 3 ♂♂ 1 ♀, JLB 12.IX.1983. – 74: Dahna Shalal, 18°55′N 42°12′E, 2300 m, BM(NH) 1985.422–26, juv., JLB 13.IX.1983. – 75: An Nimas, 19°07′N 42°09′E, 2250 m, BM(NH) 1980.306, JG VII.1980; idem, BM(NH) 1982.307–09, AKN 1982.

Description: *Bufo arabicus* is a middle sized species of the genus *Bufo*, up to 78.0 mm from snout to urostyle. Habit slender. Colour of dorsal parts (in alcohol) light yellowish-brown, more or less extensively dotted with irregular and rather small spots, that in some specimens may fuse together, forming a marbled pattern, particularly on the body sides. A couple of dark streaks extend from the nostrils to the snout tip occasionally reaching to the eye; another dark streak on the upper lip under the eye; one above tympanum; and a couple of cross bars through the center of the upper eyelids. These features represent the most constant components of the dorsal pattern. A series of more or less obscurely marked cross bars on dorsal parts of the limbs. Ventral parts solid yellowish white. Extremely variable.

Dorsal skin granulose by the presence of many flattened multispinose or multituberculate warts. A couple of rather interrupted laterodorsal glandular ridges extend from behind the mouth corners to the groin. A well defined tarsal fold. An interrupted "false" glandular ridge along the outer side of the ulna.

Head moderate 70–82% as long as broad, its length 25–28% of total body length; snout not projecting beyond the mouth, obtusely pointed in dorsal view and sloping down in a rather broken curve, when seen from the side. Canthus rostralis clearly marked, obtuse; lores flat. Nostrils set laterally behind the snout tip, the internarial distance is 70–110% of the interorbital space, which is 50–90% of the width of the upper eyelids. Tympanum small, subcircular to vertically elliptical, its maximum diameter 54–65% of the horizontal eye diameter. The distance between the eye and the tympanum is 25–35% of the maximum diameter of the tympanum. The distance between the nostril and the snout tip is 30–45% of that from the nostril to the anterior eye corner, which is 54–80% of the eye diameter. Parotoid glands flattened but distinct, elongate, their length measuring 17-20% of total body length. Males with an internal vocal sac surrounded by black pigmented muscles, clearly showing through the gular teguments, white in only 1.2% of cases.

The limbs are rather slender and long. The hand is small. Fingers are comparatively thick, the first finger measured at the base, is 40–53% as wide as its length and longer than the second, 45–52% as long as the hand and as long or slightly longer than the horizontal eye diameter. Subarticular tubercles at the base of the first phalange of first and second finger are always double; others variable. Two rather conspicuous, flattened palmar tubercles. Hind limb middle sized, 70–77% of total body length, when measured from the tip of urostyle to the tibio-tarsal articulation. When extended forward along the body, the tibio-tarsal articulation reaches the tympanum or the eye, in males, or between the shoulder to tympanum, in females. Tarsus about 30–33% as long as femur plus tibia; foot 58–70% as long as the hind limb (to tibio-tarsal joint), webbed to about half of the first phalange of the 4th toe; 53–57% of foot length. Inner metatarsal tubercle inconspicuous, flattened, 10–14% of the foot length.

Skeletal features were extensively described by Inger (1972), our results confirm his observations. The skull (fig. 9) is middle-sized, 1.29 times as broad as long and 0.49 times as wide as long; the braincase is comparatively high, 0.72 times as deep as it is broad. Frontoparietals smooth, forming a hair-line suture in the middle; sphenethmoid dorsally exposed to a rather variable extent. Canal of occipital artery anteriorly closed along ⅔ of its length. Dorsal plate of squamosal bone just overlapping the outer edge of prootic; the latter is distinct from the frontoparietal by a thin suture both in the rear side of the orbit and on the dorsal surface of the skull. Quadratojugal overlapping the maxilla in the

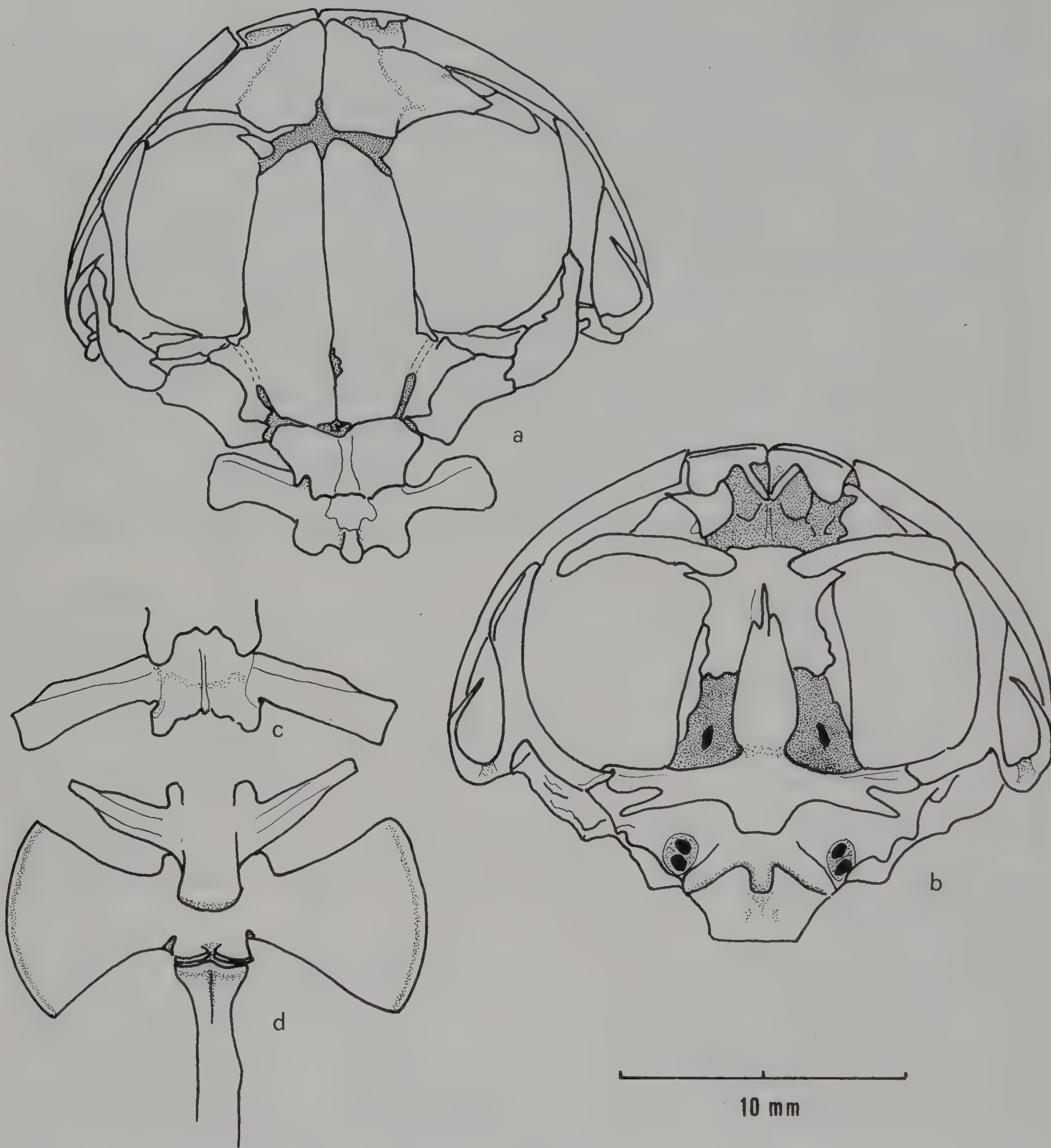



Fig. 9: Skeletal features of *Bufo arabicus* from Hamman Ali, ♀ (IZUG). a, Dorsal and b, ventral views of skull. c, 3rd vertebra from dorsal view. d, 7th and 8th (sacral) vertebrae from ventral view.

posterior part of the pterygoid-parasphenoid angle, viewed from the rear. No transverse parasphenoid ridge; platine bones smooth. The length of transverse processes of the 3rd vertebra equals 84% of the skull length; that of the transverse processes of the 7th vertebra represents 73% of the 3rd. The width of the diapophysis of the sacral vertebra (8th) is about 45% of the skull length. Vertebral column with a single median crest.

Variation: Sexual dimorphism of *Bufo arabicus* is rather evident. Males can be easily recognised by their black vocal sac, extended single keratinisation on the mesial side of their first finger, slenderer

habit and smaller size. Mature males measure 37–66.5 mm from snout to urostyle; females from 52.5 to 78 mm. Females also have shorter legs, slightly larger tympanum and a thinner first finger. Colour variation is rather wide, mostly being a consequence of individual, rather than population differences. Some specimens, particularly males, have a solid-dark dorsal colouring, occasionally punctuated by the light brown dorsal tubercles. Specimens of both sexes may often have a thin or slightly wider lighter coloured vertebral stripe.

Tadpole: The tadpoles of *Bufo arabicus* (fig. 10) may have been first described by ANDERSON (1895) as larvae of *Bufo andersonii* Boulenger (which he figured on pl.27, figs 3, 3a). We examined more than 200 tadpoles of this species from various Arabian localities, as previously outlined. These tadpoles are rather large, up to 50 mm long from snout to tail tip; the colour, in alcohol, is very dark olive grey, above, and lighter grey on the underside. The sides of tail are of the same dark colouring as the dorsal parts of the body, or lighter greyish-brown, more or less extensively mottled darker. Caudal membranes are unpigmented and transparent, occasionally with some darker mottling, particularly on the dorsal membrane. Nostrils are set closer to the eye than to the snout's tip in lateral view, and at about midway between the two in dorsal view; the internarial distance is 60–70% of the interorbital space; the eye diameter 7.6% of total body length; the distance from the pupil to the tip of snout is 45% of that to the base of the anal siphon, and 93% of that to the spiracle opening. The latter is on the left side of the body, ventrolateral, not visible from above and set at two-thirds of the body length, directed horizontally backwards. The body length is about 40% of total length; the anus is median. The tail is rather

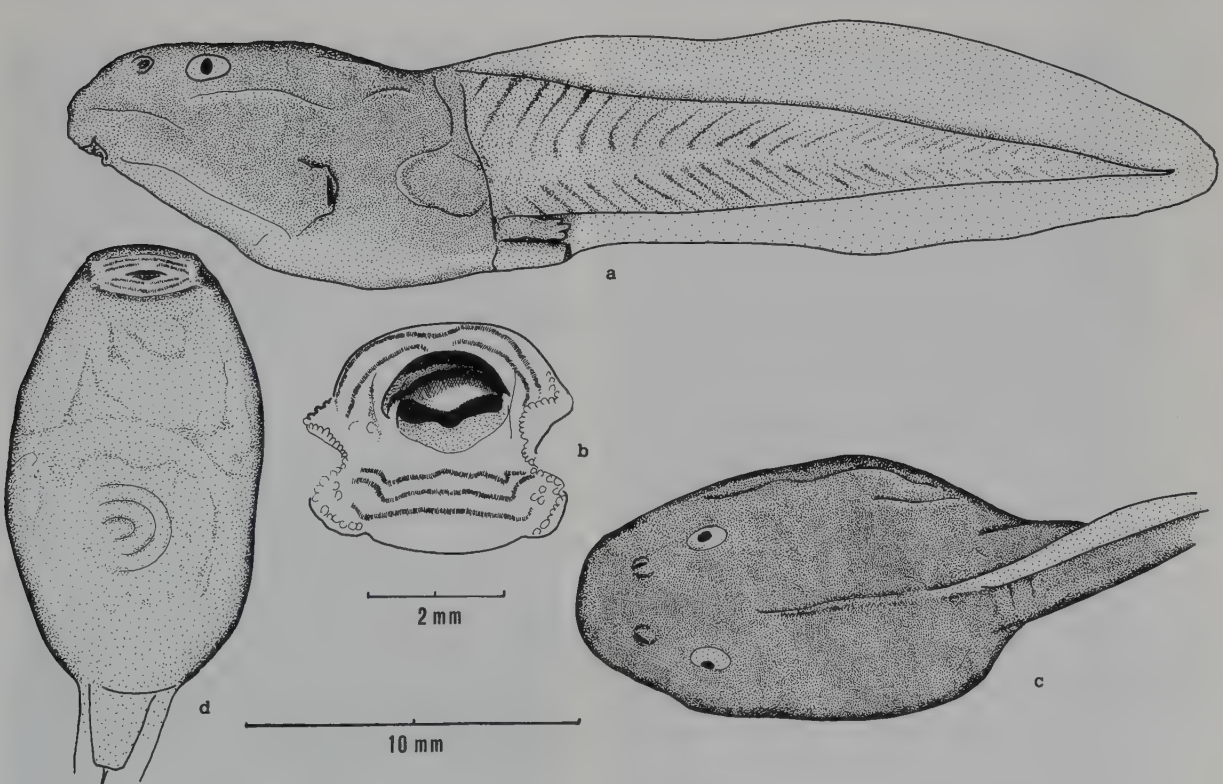



Fig. 10: Tadpole of *Bufo arabicus* from Haddah, GS 5.IX.1965 (IZUG). a, Lateral view of tadpole. b, Larval mouth. c, Dorsal and d, ventral views of tadpole.

acuminate, strongly tapering backwards. The upper caudal membrane is scarcely convex and does not extend on the body beyond the vertical line passing by the insertion of the hind limbs and the base of the anal siphon. In the larval mouth, rostrodonts are normally sclerotised, finely crenulated in the middle. Keratodonts are set in five rows corresponding to the formula 1, 1+1/3. The second row of the upper lip is rather widely interrupted in the middle. Under strong magnification they show the normal flat and fringed tip, that is characteristic for most species of the genus *Bufo.*

Biology: Eggs, upon deposition, are small, 1.4 mm in diameter, and very tightly packed in a single longitudinal series. They were collected from a spawning pair at Hamman-Ali, 7.IX.1965, by Prof. G. Scortecci. After the gelatinous membrane hydrated, they were contained in a transparent cylindrical tube having a diameter (in alcohol) of about 4 mm. Single egg cells are blackish brown and at this stage have a diameter of 1.8 mm. Contrary to what is normally found for European *Bufo viridis,* eggs remain arranged in a single row (Rasyan 6.X.1965). Tadpoles of *Bufo arabicus* were collected in the localities and on dates reported in tab. 2. With some allowance made for annual variation in rainfall periods and altitudinal factors, it might be argued that in the Asir and in Yemen there are two main reproductive seasons for *Bufo arabicus*, one in September–October, and one in June–July, both periods immediately following the rainfall seasons. In more general terms, the breeding season follows the rains, whenever they occur.

Systematics: The synonymic list clearly reflects the state of confusion that characterised the systematics of this species until very recent years. Apart from some very old misidentifications, as with *Bufo vulgaris* Laurenti (a synonym of *Bufo bufo* Linné), most of the problems came from the very broad interpretation that was at one time accorded to the species complex of *Bufo regularis* Reuss. *Bufo pantherinus,* for instance, was once considered to have been published first by Boie (1829), or by Tschudi (1839). Both names are to be considered as nomina nuda under the ICZN, as they were published without an accompanying description. *Bufo pantherinus* shall therefore take authorship and date of priority from Duméril & Bibron's (1841) publication thereby becoming a junior subjective synonym of *Bufo regularis* Reuss, as was noted by Loveridge (1957) who, accordingly, selected "Egypt" as the type locality of *Bufo pantherinus* Duméril & Bibron. The first author who considered these Arabian *Bufo* specifically distinct from the *Bufo regularis* complex was Parker (1941) who suggested, however, that it might prove conspecific with the African *Bufo blanfordi* Boulenger, 1882. The latter species was later placed in a rather removed group of genus *Bufo* characterised by an acuminate snout and inconspicuous parotoid glands (Tandy & Keith 1972).

More taxonomic and nomenclatorial problems derived from the fact that Boulenger (1883) included in his type series of *Bufo andersonii,* a specimen originally said to be without locality, but subsequently found to have been collected at Muscat (Boulenger 1887: 408). This specimen is now thought to belong to *Bufo arabicus* (Parker 1938: 491, as *Bufo viridis* var. *orientalis* Werner), while *Bufo andersonii* is currently considered to be a synonym of *Bufo stomaticus* Lütken, 1863 (see Eiselt & Schmidtler 1973, Dubois 1974, for a more extensive discussion). The reason it was not realised that this Arabian toad corresponds to *Bufo arabicus* Heyden ([4]) was mainly the result of a mistake by Mertens (1957) who considered that Heyden's name referred to a subspecies of *Bufo viridis* distributed from Sinai (= "Arabia Petraea") to southern Iran. As Mertens had at his disposal Heyden's type specimen, his assumption was never questioned by later authors (Mertens 1969, Eiselt & Schmidtler 1973). The examination of the holotype of *Bufo arabicus* Heyden, and of the lectotype of *Bufo orientalis* Werner (BM(NH) 1895.11.1.2, ♂, retagged as BM(NH) 1947.2.20.45, from Muscat, herewith designated) made it clear that they are to be regarded as conspecific.

([4]) Tandy & Keith (1972: 160) placed *Bufo arabicus* Heyden in the "*Bufo orientalis* group" (sensu Inger, 1972) with an interrogation point and without any further comments.

10c

10d

10a

10b

Plates 10 a–d: *Bufo arabicus.*

**Table 2: Development of tadpoles of *Bufo arabicus*.**

| Date | Locality | Elevation (m) | Tot. length (range; mm) | Legs | Young | G/S |
|---|---|---|---|---|---|---|
| 12.IX.80 | Wadi Maqsala | 2000 | 10–22 | 0 | 0 | 25–26 |
| 15.IX.65 | Sana'a | 2400 | 15–27 | 0 | 0 | 25–31 |
| ??.IX.79 | Wadi Maqsala | 2000 | 24–34 | 1–2 | 0 | 26–36 |
| 5.IX.65 | Haddah | 2400 | 31–41 | 1–3 | 2 | 31–38 |
| 29.IX.65 | Al Haurat | 1250 | 38–42 | 3 | 2 | 36–44 |
| 4.VII.81 | Wadi Yeslem | 1830 | 23–36 | 0–1 | 0 | 34–37 |
| VI./VII.81 | Ju Amlah | 1950 | 24–41 | 1–3 | 1 | 34–38 |
| 13.VI.81 | Wadi Sheba | -- | 39–50 | 3 | 1 | 35–40 |

Legs: 0 = absent, 1 = small, 2 = middle-sized, 3 = completely developed. Young (just metamorphosed): 0 = absent, 1 = few, 2 = many, G/S = Gosner's (1960) stages (tadpoles only).

The fact that *Bufo arabicus* Heyden represents a completely distinct species with respect to *Bufo viridis* and its complex is apparently beyond any reasonable doubt. Inger (1972) reports not less than eleven osteological characters upon which the two species appear to differ (44% of characters checked). *Bufo arabicus* (as *Bufo orientalis*) has a narrower skull, a deeper braincase, separated frontoparietal bones, an exposed occipital canal, a prootic bone separated from frontoparietal, a quadratojugal overlapping the anterior half of pterygoid fenestra, an interpterygoid angle larger than the pterygoid-parasphenoid angle, a broader 7th transverse process, different third spinal nerve foramen, differently shaped humerodorsalis muscle (not sending a main slip to the fourth finger). The two species, accordingly, were classified in two separate, and rather removed, species-groups (see the tab. 8.1 and dendrograms of figs 8.1–8.4 in Inger's paper). Other morphological and biometrical differences set aside, it is relevant to consider that *Bufo arabicus* and *Bufo viridis* are sympatric in several Arabian localities (Bani Mashoor, An Nimas, near Sawdah and at Petra, Jordan).

Distinguishing *Bufo arabicus* from the complex of *Bufo regularis* is rather easy, as all species of the "*regularis* group" have a granulose gular skin, very often tinged black or dark, and much larger tympanum, close in size to the eye diameter. Osteological characters allowing them to be set into separate species groups are listed by Inger (1972: 115 and tab. 8–1).

A last problem arising from the discovery that *Bufo arabicus* Heyden, 1827 is the proper name for this Arabian toad, is the extent of its distribution. The northernmost locality so far known for *Bufo arabicus* is Jabal Dabbagh. Its type locality (das peträische Arabien) was long considered to be situated in the Sinai. The only toad recently recorded from the latter locality (Schmidt & Marx 1956) is, however, "*Bufo viridis viridis* Laurenti" and it is doubtful whether it is appropriate, now, to select a "locus typicus restrictus" for this species. Though we strongly feel that the type locality is probably "Midyan", Heyden clearly stated "Das peträische Arabien". He may not have had Rüppell's geographical dissertation and excellent map at his disposal (Rüppell 1829: pl.11) since its publication date is two years later. In any event, Rüppell (1845) in his catalogue of specimens in the Senckenberg Museum refers to *Bufo pantherinus* var. *arabicus*, citing not Heyden, but "Rüpp. Atlas, Rept. Taf. 5. Fig. 2" without further comment. More collecting on both sides of the Gulf of Aqaba is necessary before a positive conclusion can be made.

Ecology: *Bufo arabicus* is an opportunistic, mesophilous species, encountered in almost all environments of the peninsula where there is some water availability. It is found to be sympatric with all the species of Arabian Anura except *Bufo hadramautinus*; this species, and *Bufo dhufarensis* replace *Bufo arabicus* in the Hadramawt. *Bufo arabicus* is not found in Dhofar where *Bufo dhufarensis* is the only known amphibian form. However, in Oman the two species are sympatric, though *Bufo dhufarensis* is predominant. *Bufo*

*arabicus* has not been found in the oasis complex of Riyadh where until only recently (see *Euphlyctis ehrenbergii*, "Ecology"), *Bufo dhufarensis* was the only known amphibian. However, a few hundred kilometers southward near Layla, in the ancient Al Aflag oases, *Bufo arabicus* is the only Anuran recorded. In the rugged mountainous areas of the northwest, the ancient Midyan, where precipitation is scant (50 mm per annum), though there are permanent water sources as is evidenced by the continued existance of the ibex *Capra ibex nubiana* (that requires water daily), *Bufo arabicus* is the only amphibian collected. Further north Jabal Dabbagh, Midyan, Wadi Karagir and Dar al Nasara are the northern limits of the distribution of *Bufo arabicus*. There is a great gap of distribution (or more likely, collecting activity) southward to near Al Majmaa (23°N) where it is found sympatric with *Euphylctis ehrenbergii* at the northern limit of the distribution of the latter species. From the latitude of Makkah/Taif, i.e., 21°30'N, southward through the Asir, Yemen and Aden, *Bufo arabicus* is the most common Anuran species, especially in the higher altitudes where it shares the habitats of the Palaearctic relicts in the high montane, well watered reaches of the highlands as well as being common in the less verdant lowlands, sympatric with *Bufo tihamicus* in most of its distributional range.

The paradox of species distribution is further complicated with reflection on the ancient oases complex of Domat al Jandil (Al Jawf) and Sakaka, where the history of abundant water resources reaches into antiquity. The junior writer spent weeks in the area only to conclude that there are no amphibia in the lush oasis areas or the historic drainage swamp formed by the outflow therefrom.

*Bufo arabicus*, like *Bufo dhufarensis* are most commonly found in situations where there is some annual precipitation and flooding and ponding. However, either species has also been known from localized areas where rainfall and flooding may not occur for a year or two years or more, indicating the ability to sustain prolonged aestivation.

### ***Bufo hadramautinus*** Cherchi, 1963

*Bufo hadramautinus* Cherchi, 1963: 5, figs 1, 2.

*Bufo hadramautinus* Cherchi. – Balletto & Cherchi 1971: 29; Arnold 1980: 276.

Holotype: IZUG 5, ♀, Suia, 14°45'N 48°48'E, 1160 m, G. Scortecci 29.IV.1962 (see map, fig. 2: 1).

Other material (17 specimens; see map, fig. 2): 1: Suia (see above), IZUG 1–4, 6–17, 6 ♀♀ 10 ♂♂, GS 29.IV.1962. – 2: Ingrams, 14°36'N 49°01'E, 760 m, IZUG, 1 ♀, GS 30.IV.1962.

Description: Probably the smallest species of the genus *Bufo* in Arabia, up to 61 mm from snout to urostyle. Habit rather slender. Colour of dorsal parts (in alcohol) roseate hazel-brown, irregularly dotted with small brown spots and more or less punctuated by whitish dots set in correspondence to dorsal warts. A couple of chestnut-brown stripes running from the tip of snout through the nostril and the eye to the upper edge of the tympanum and the outer sides of the parotoid glands, together with a couple of ventrolateral stripes running from the shoulder to near the groin, represent the most constant features of the colour pattern. A brown spot beneath the eye, on the upper lip, and one or two such markings below the tympanum, may also be present in most specimens. No real cross-bars on the upper eyelids, although some irregular markings may be on this region in a few specimens. A series of well developed cross bars on the upper sides of limbs. Underside creamy-white. Dorsal skin strongly granulose by the presence of many large, prominent warts, each 1–4 mm in diameter, each bearing a single central spine or mucro. No dorsolateral glandular ridges. A well defined tarsal fold running along the lower edge of the tibio-tarsal segment; a series of longitudinally arranged tubercles along the ulnar side of the fore-arm.

Head moderate, its length is 72–79% of its width and 26–29% of total body length; snout not projecting beyond the mandible, obtusely pointed in dorsal view, and sloping down in a practically contin-

uous curve, when seen from the side. Canthus rostralis well marked, obtuse; lores almost flat. Nostrils set laterally behind the snout tip, the internarial distance being practically equal to the width of the interorbital space (i.n.d./i.o.s. : 0.90–1.13). The latter is 56–65% of the width of upper eyelids. Tympanum small, vertically elongated, its maximum diameter is about 60–76% of the horizontal diameter of the eye. The minimum distance between the eye and the tympanum is about 13–26% of the vertical diameter of the tympanum. The distance between the nostril and the tip of snout is 50–80% of that from the nostril to the anterior eye corner. The latter distance is 58–77% of the horizontal diameter of the eye. Parotoid glands flattened but distinct, kidney-shaped, their length 16–21% of total body length. Males with an internal vocal sac surrounded by unpigmented or scarcely pigmented muscles, not or feebly showing through the gular skin.

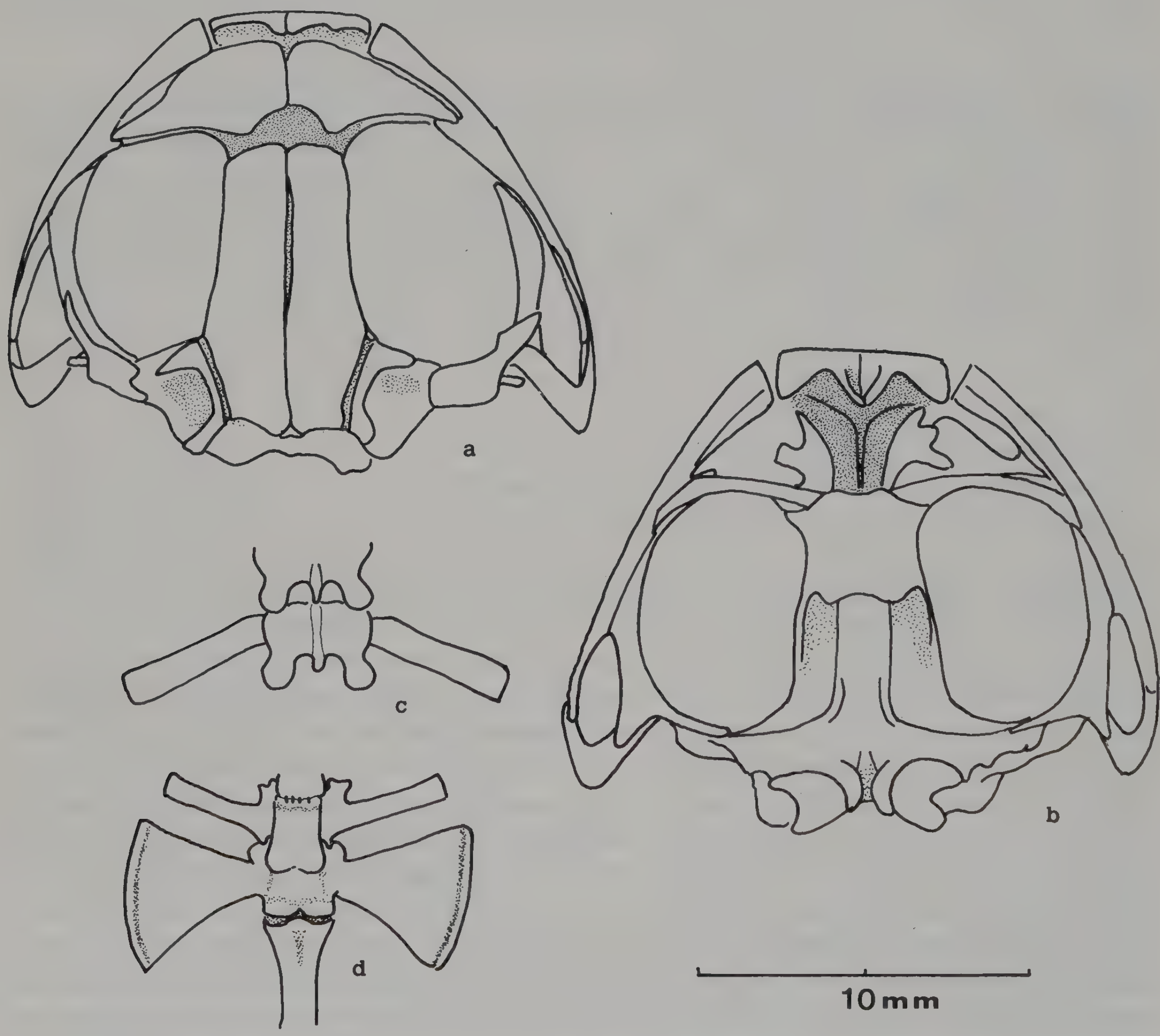



Fig. 11: Skeletal features of *Bufo hadramautinus* from Suia, ♀, IZUG 1. a, Dorsal and b, ventral views of skull. c, 3rd vertebra from dorsal view. d, 7th and 8th (sacral) vertebrae from ventral view.

Limbs comparatively slender and long. Hand middle sized; fingers rather long and slender, the first one, measured at the base, is 29–40% as thick as its length. First finger longer than the second one, measuring 42–51% of the length of the whole hand, and about as long as the horizontal diameter of eye; subarticular tubercles prominent and practically all double. Two rather prominent palmar tubercles. Hind limb middle-sized, 71–79% of the body length, when measured at tibio-tarsal articulation. When extended forward along the body the tibio-tarsal joint reaches the eye, in males or the tympanum, in females. Tarsus 30–34% as long as the tibia plus femur. Foot 57–68% as long as the hind limb (to tibio-tarsal articulation), webbed to the second third of the first phalange of the fourth toe, 57–62% of the foot length. Inner metatarsal tubercle inconspicuous, flattened, 10–12% of the foot length.

*Bufo hadramautinus* is characterized by having a rather broad, shallow skull (fig. 11), 1.42 times as broad as long and 0.42 times as high as long. The depth of the braincase is 69% of its width. Frontoparietals smooth, forming a thin suture in the middle; sphenethmoid completely exposed on the dorsal surface of the skull. Canal of the occipital artery dorsally open along its entire length. Dorsal otic plate of the squamosal overlaying the prootic by about ⅓ of its length; the latter bone is separated from the frontoparietal. Quadratojugal overlapping the maxilla in the anterior part of the pterygoid fenestra. Intrapterygoid angle smaller than the pterygoid-parasphenoid angle. A shallow, obtuse transverse parasphenoid ridge; palatine bones smooth. The length of the transverse processes on the 3rd vertebra equal to 96% of the skull length; the length of the same processes on the 7th vertebra is 75% that of the third. The width of the transverse process of the 8th (sacral) vertebra equals 37% of the skull length. A single median vertebral crest is formed by the dorsal neural spines. The skull of *Bufo hadramautinus* is broader than that of *Bufo arabicus,* shallower and provided with a less deep braincase. The completely exposed canal of its occipital arteries and the more developed dorsal otic ramus of the squamosal seem to place it in a position rather intermediate between the two species. It differs from both, though, by the feebly developed lateral processes of the 8th vertebra and by the general morphology of the occipital zone (see fig. 11 and tab. 1).

Variation: Sexual dimorphism in *Bufo hadramautinus* appears very weak, perhaps as a consequence of the fact that specimens at hand were not collected at peak of the breeding season. Sexing specimens may require dissection; in other cases males can be identified by their greyish gular sac or by the weakly developed keratinisation of the mesial side of their first finger. Males measure about 48–56 mm from snout to urostyle; females 47–61 mm. Females may have a more granulose dorsal skin, with larger warts, and slightly more extensively webbed feet. A more detailed description of variation in many morphological characters was reported by Cherchi (1963).

Tadpoles: The larvae of *Bufo hadramautinus* have not been collected.

Systematics: Certainly *Bufo hadramautinus* can be considered closely related to *Bufo arabicus* Heyden, of which it might be subjectively held to constitute an allopatric subspecies. The fact that rather typical populations of *Bufo arabicus* are found in complete isolation in the United Arab Emirates and northern Oman is indicative of the possibility that *Bufo hadramautinus* represents an older branch of the main stock of *Bufo arabicus.* Lacking more biological evidence of the relationships in this rather complicated complex of the genus *Bufo,* we prefer, therefore, to consider them as distinct morphospecies. The two species, in fact, can be separated rather easily both on general characters of their external morphology and on some biometrical parameters. Morphologically, *Bufo hadramautinus* is identified by its monospinose, big, dorsal tubercles; by its peculiar dorsal pattern, always lacking the dark cross-bars that represent a constant feature of *Bufo arabicus* (as well as of many other species of *Bufo*); by its reduced dorsolateral glandular folds, edged, beneath, by a dark brown longitudinal stripe; by the much slenderer fingers, and more extensively webbed feet. Additional characters are provided by their slightly larger tympanum set closer to the eye, and by their slightly larger hands, in both sexes.

Ecology: The type locality of *Bufo hadramautinus*, the oasis of Suia, lies in a relatively deep, small valley, where a spring feeds a small cistern surrounded by sparse cultivation of date palms, papayas and banana trees. The water temperature was 35°C during the day and 16°C at night. Water was heavily loaded with dissolved salts with a pH of about 5.6. The toads spent only a few hours in the water, at night-time. During the day they sheltered in crevices in the rocks and under large boulders. *Bufo hadramautinus* appears to be a more xerophilous species than *Bufo arabicus*.

***Bufo scorteccii*** Balletto & Cherchi, 1970

*Bufo scorteccii* Balletto & Cherchi, 1970: 34

*Bufo scorteccii* Balletto & Cherchi. – Balletto & Cherchi 1971: 29; Arnold 1980: 276.

Holotype: IZUG 4, ♂, Mafhaq, 15°07'N 43°54'E, 1550 m, G. Scortecci 28.VIII.1965 (see map, fig. 2: 1).

Other material (24 specimens, 200 larvae; see map, fig. 2): 1: Mafhaq (see above) IZUG 1–3, 5–25, 21 ♀♀ 3 ♂♂, GS 1965. – 1: Wadi al Khalili nr Mafhaq (see above), IZUG, approx. 200 tadpoles, GS 28.VIII.1965.

Description: A small species of the genus *Bufo*, up to 62.5 mm from snout to urostyle. Dorsal parts chestnut brown, obscurely mottled with darker spots; normally a dark cross bar between the eyes and a small vertical bar on the upper lip, beneath the eye center. A more or less well defined whitish vertebral line, running from the shoulder region to the vent was noted in 5 specimens. Lateral part of the parotoid glands pigmented dark brown. Limbs with some faintly defined cross bands. Underside whitish to brownish. Habit very slender. Dorsal skin moderately granulose, with the presence of several scarcely prominent, obtuse, multituberculate warts. Underside granulous. No real dorsolateral glandular ridges, of flaps.

Head moderate, its length is 77% of its width and about 27% of total body length. Snout not projecting beyond the mandible, truncate in dorsal view, vertical in lateral view. Nostrils set at the sides of the truncate snout, level with its tip, the internarial distance is about 60% of the interorbital space; the latter is about 87% of the width of the upper eyelid. A feebly defined cross-fold behind the upper eyelids, joining the centers of the upper edges of tympana. Parotoid glands distinct, but flat and of variable size, their length is 15–16% of total body length. Tympanum distinct, the diameter is about 61% of the horizontal diameter of the eye, separated from it by a space about 30% the horizontal diameter of the tympanum. The distance between the nostril opening and the anterior eye corner is about 77% the horizontal diameter of the eye. Males with a single, internal vocal sac, surrounded by black pigmented muscles, clearly showing through the gular skin.

Limbs very slender. Hand moderate, fingers comparatively very thin, the width of the first one, measured at the base, is 25–30% its length, in breeding specimens of both sexes. Subarticular tubercles always simple, prominent. Two rather conspicuous, flat palmar tubercles. Ulnar ridge absent or very feebly marked. Hind limb rather long, about 77% of total body length measured to the tibio-tarsal articulation, being extended forward along the body the tibio-tarsal articulation reaches the rear corner of the eye, or the eye center. Tarsus 31% of the hind limb. A thin, rather distinct tarsal ridge running along the inner margin of the tarsal segment, to the base of the metatarsal tubercle. Foot about 60% as long as the hind-limb (tarsus excluded), webbed to about half of the first phalange of the fourth toe; metatarsal tubercle small, 8–13% as long as the fourth toe.

The skull of *Bufo scorteccii* (fig. 12) is characterised by a complex of features that contribute to this species being closer to the group of *Bufo dhufarensis* (Inger's "*stomaticus* group") than to that of *Bufo arabicus* (Inger's "*orientalis* group"). It has a completely exposed canal of the occipital artery and a rather well developed otic plate of the squamosal bone. The vertebral column is also of the anteriorly broad,

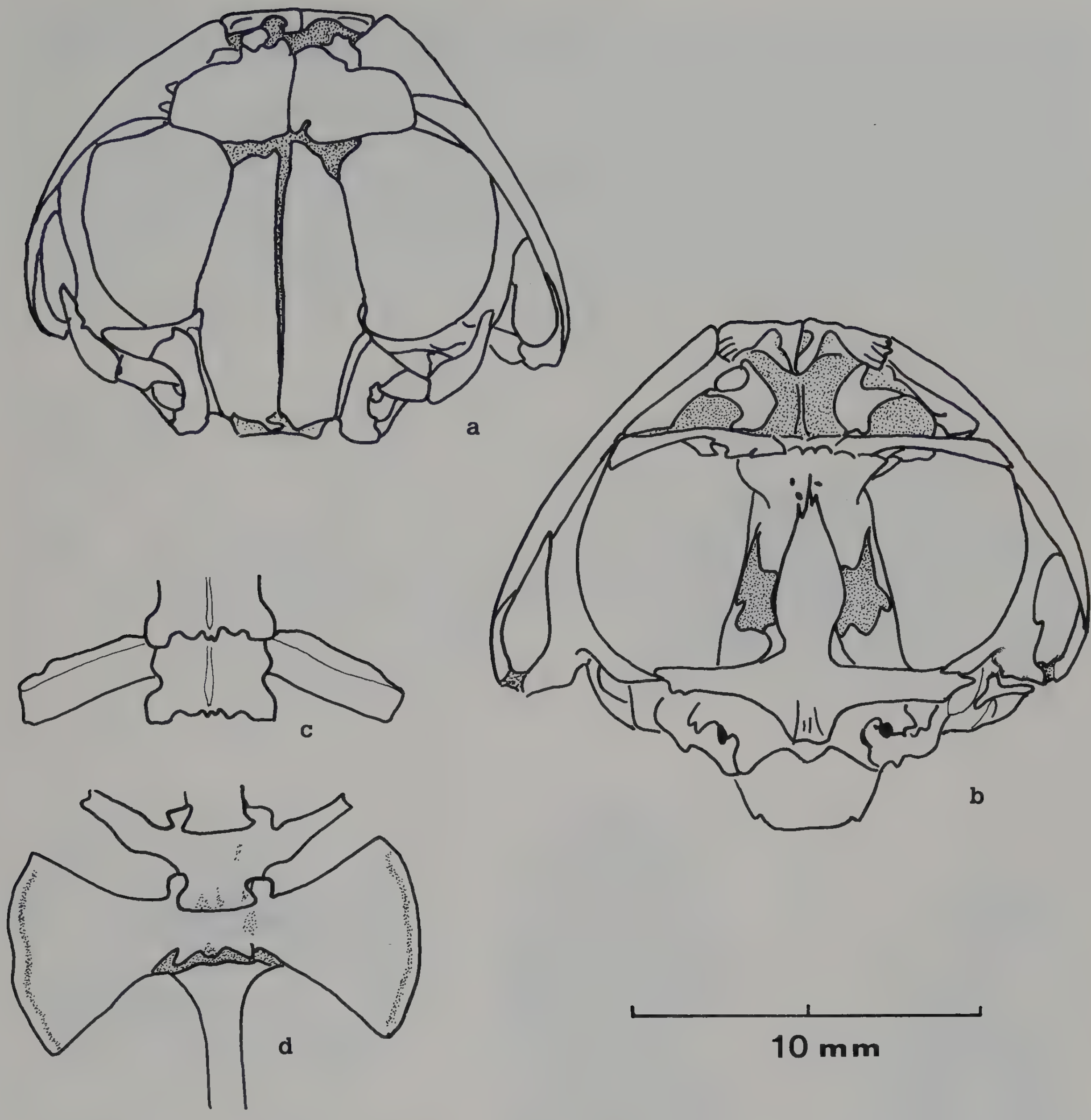



Fig. 12: Skeletal features of *Bufo scortecci* from Mafhaq, ♀ (IZUG). a, Dorsal and b, ventral views of skull. c, 3rd vertebra from dorsal view. d, 7th and 8th (sacral) vertebrae from ventral view.

posteriorly tapering type, that is found in *Bufo dhufarensis*, the ratio of the 3rd transverse process/skull length (to anterior nasal suture) being of about 1.0 and that of the width of the 7th transverse process/ 3rd of about 0.7 (see figs 6 and 12). It differs, though, from both species, as well as from all Euroasiatic species of *Bufo* so far investigated (Inger 1972) by the very broad transverse processes of 8th (sacral) vertebra, the ratio of which to the skull length is about 0.52 therefore, larger than the highest known value of 0.45 (see taxonomic character No. 21, tab. 1). The other skeletal features of *Bufo scorteccii* are the following: Ratio skull width/skull length: 1.4; skull height/skull length: 0.44; braincase depth/ braincase width: 0.8; dorsal surface of skull smooth; frontoparietals scarcely separated on midline; sphenethmoid completely exposed in dorsal view; prootic bone distinct from frontoparietal;

quadratojugal overlapping in the anterior half of pterygoid fenestra; interpterygoid angle larger than pterygoid-parasphenoid angle; no transverse pterygoid-parasphenoid ridge; palatine smooth; vertebral column with a single median crest; no cranial crest.

Variation: Sexual dimorphism in *Bufo scorteccii* is slight. The only character allowing a prompt identification of mature males is the black gular sac, clearly seen through the gular skin. No keratinisation on the hand of any of the breeding males examined. Males scarcely smaller than females (44.1–51.0 mm long rather than 43.5–62.5 mm). Males appear to have comparatively larger feet, measuring 63% (± 0.026) of the hind limb, rather than 56% (± 0.075) as in the females. They also have comparatively smaller metatarsal tubercles, the inner one being only 0.08% (± 0.005) of the foot length, rather than 11% (± 0.02) as in the females. Several biometrical measurements taken on the type series of this species were listed by BALLETTO & CHERCHI (1970).

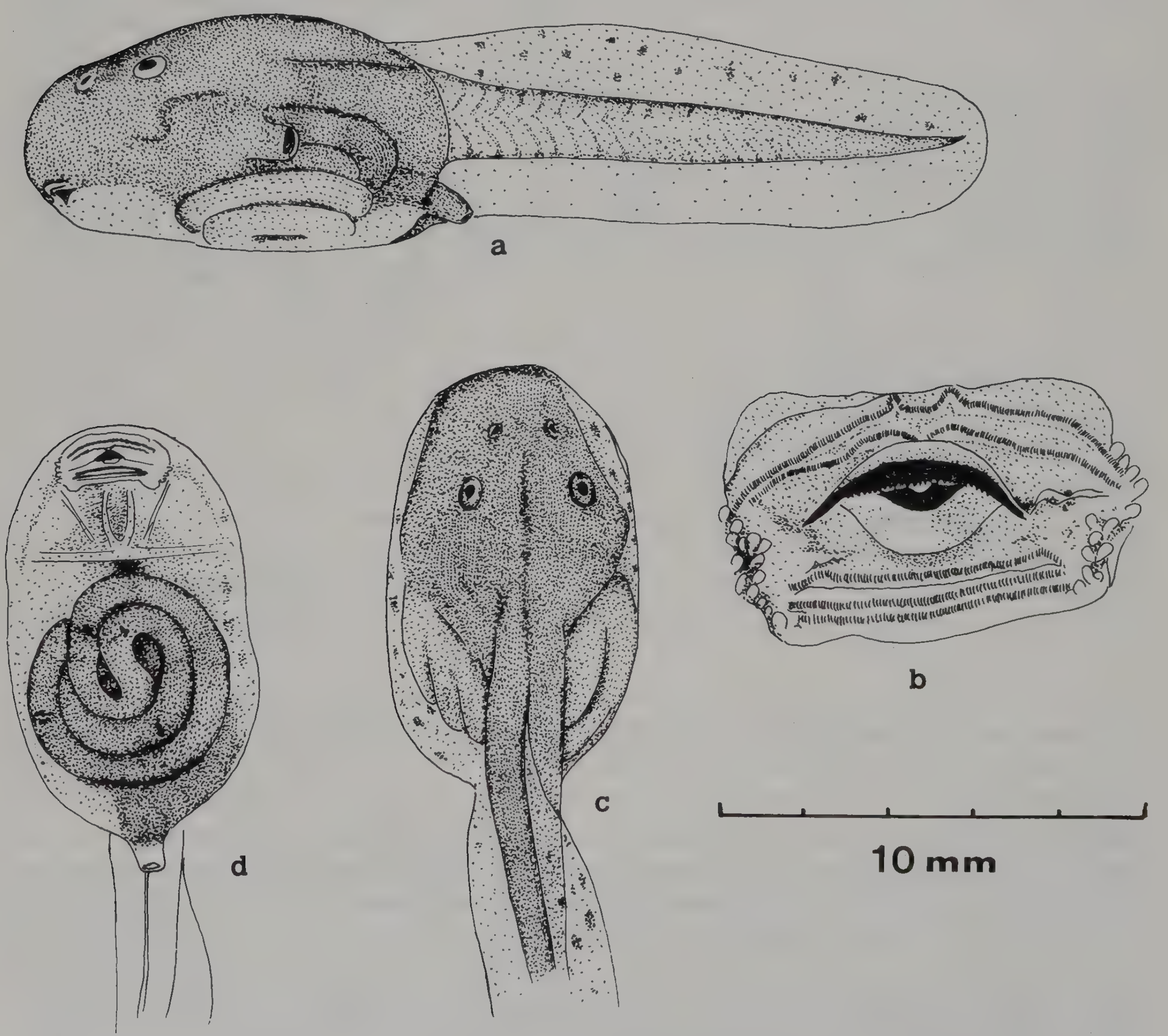



Fig. 13: Tadpole of *Bufo scortecci* from Wadi al Khalili nr Mafhaq, GS 28.VIII.1965 (IZUG). a, Lateral view of tadpole. b, Larval mouth. c, Dorsal and d, ventral views of tadpole.

Tadpole: Some 200 tadpoles (stages 24–27) apparently referable to this species (fig. 13) were collected together with their adults in the Wadi al-Khalila, near Mafaq on 28.VIII.1965, by Prof. G. Scortecci. They are all very young and of a similar size. They measure 19.4–20.2 mm total length, all of them are legless. Colour in alcohol is uniform light reddish-brown, both on the body and the sides of the tail; the belly and the caudal membranes are colourless. Nostrils are set much closer to the eye than to the snout, the internarial space is about 60% the interorbital. The eyes are rather large, set on the upper surface of the head, at about ⅓ of the body length in lateral view; their distance to the snout's tip is practically identical to that to the spiracular opening. The spiracle is ventrolateral, not or barely

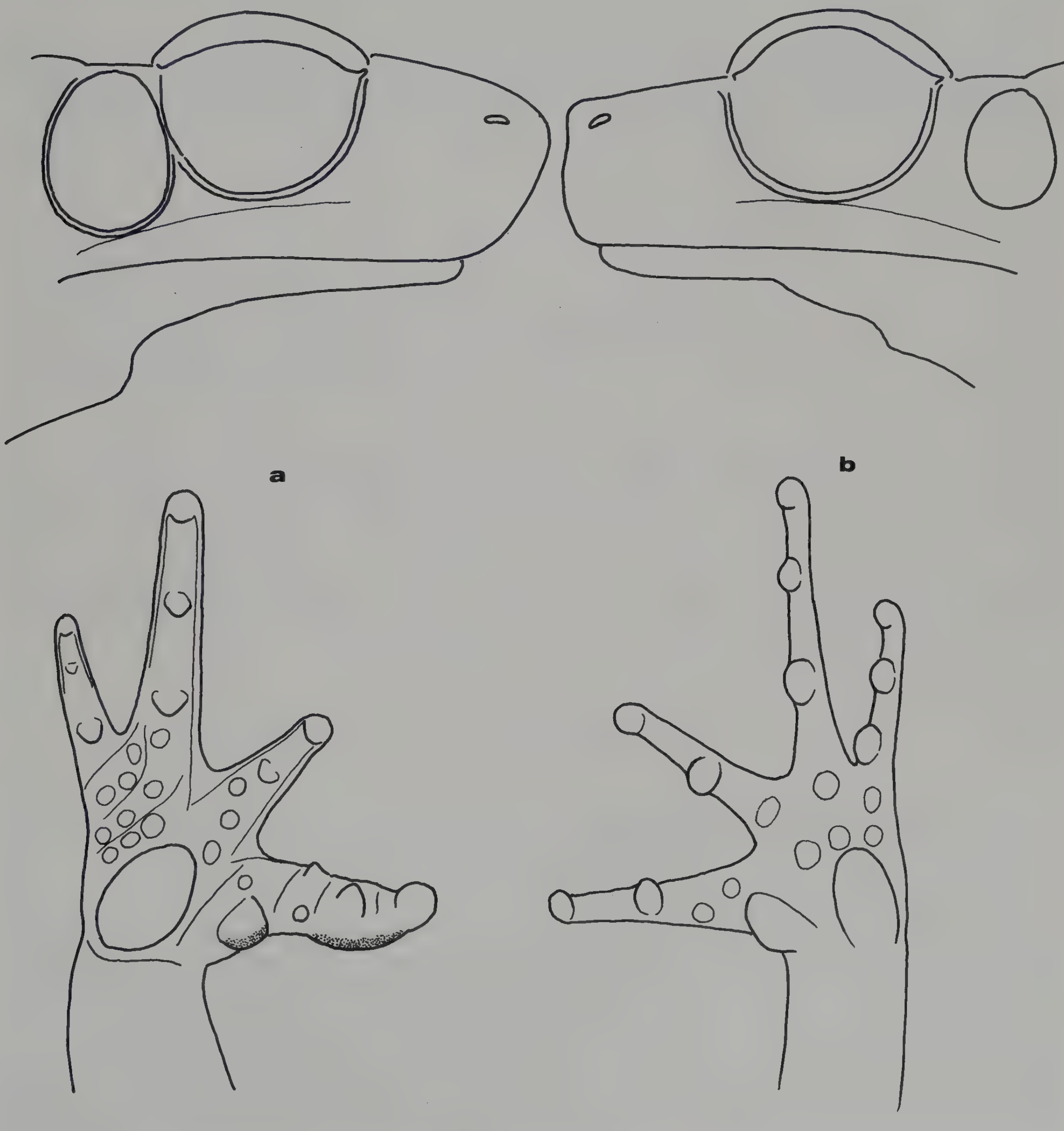



Fig. 14: Shape of snout and hands of *Bufo dhufarensis* (a) and *Bufo scortecci* (b).

visible in dorsal view, on the left side of the body, directed backwards, set at about 66% of the body length, which is 37% of total length. The anus is median. The tail, in side view, is practically rectangular, its upper and lower membranes running about parallel to each other and coming rather abruptly to a blunt tip. The upper caudal membrane does not extend on the body. The larval mouth is similar to that which is usual in the genus *Bufo*. Rostrodonts are transversely rather elongate and not strongly sclerotized; keratodonts are set in the usual five rows, corresponding to the formula:

$$\frac{\begin{matrix}1\\1\quad1\end{matrix}}{3}$$

the second row of the upper lip is only narrowly interrupted. Under strong magnification, keratodonts show the structure with a flattened and curved tip, rounded and fringed at the outer margin, normally found in the genus *Bufo*.

Systematics: The taxonomic position of this small, slender toad, appears to be somewhat intermediate between *Bufo arabicus* and *Bufo dhufarensis*. With *Bufo arabicus* it shares many characters of the adults, particularly from the point of view of biometrical measurements. The only diagnostic measurements are represented by its comparatively much longer hind limbs, slenderer fingers and limbs and always simple metatarsal tubercles and thin general habit. Adults of both sexes lack the sub-ulnar and dorsolateral ridges characteristic of *Bufo arabicus,* and the granulous fold above the vent. The shape of the snout is also different. *Bufo dhufarensis* and *Bufo scorteccii* share the general shape of the snout, in dorsal and ventral view, however, the two species differ by the presence, in *B. dhufarensis,* of very large and prominent dorsolateral flaps, that are missing in *Bufo scorteccii;* different shape of the snout in lateral view (fig. 14); very different relative size of the tympanum; and several other biometrical measurements. The tadpoles of *Bufo scorteccii* are apparently closer to those of *Bufo dhufarensis*. They can be easily distinguished, however, by their much less interrupted second row of keratodonts, on the upper lip, and lateral shape of the tail.

Ecology: Specimens of the type series were collected on 25.VIII.1965 in pools of still water in the banks of Wadi al-Khalili, near Mafhaq. All individuals collected were mating and were found together with very small tadpoles of the same species, as outlined above. At 8:30 in the morning, when specimens were collected, air temperature was 26°C, while the temperature of the water was from 28–30°C depending on exposure to the sun. These specimens, which were quite active, were collected in cohabitation with *Bufo arabicus*, which were mostly sheltering in the vegetation on the banks of the small stream. Mafhaq is at an altitude of about 1550 m, on a high plateau.

## Genus ***Hyla*** Laurenti, 1768

*Hyla* Laurenti, 1768: 32. Type species: *Hyla viridis* Laurenti, 1768 – ibid.: 33; by selection by Mertens & Müller (1928: 19). Invalid selection: *Hyla boans* Daudin, 1802: 31, pl.11.; by Fitzinger (1843: 30).

*Hyas* Wagler, 1830: 201. Type species: *Hyla viridis* Laurenti, 1768: 33

*Dendrohyes* Wagler, 1830: 342. Unnecassary substitution.

Nomenclature and systematics: The synonymy of the genus *Hyla* represents one of the most difficult to draw among the Anurans. Very little consensus exists among specialists as to the systematic value of several generic names, mostly assigned to taxa of the Southern Hemisphere. The entire genus is badly in need of complete taxonomic revision, except for those of South America. Listing all of the possible subjective synonyms of the genus *Hyla* would be of little consequence for the purposes of the present paper. Interested readers are, therefore, referred to the provisional lists supplied by Duellman (1977) and Gorham (1974), or even the older lists reported by Boulenger (1882a, 1890 etc.); see also Liem (1970) for discussion of some related problems.

The state of generalised confusion characterising the species-level taxonomy of *Hyla* is a result of considerable difficulty in giving a clear definition of its characters. Although many authors dealt with some geographically identified faunas (COCHRAN 1955, COCHRAN & GOIN 1970, CEI 1980, LUTZ 1968, TYLER 1971, COGGER 1975, LIN 1950, SCHMIDT 1939, MERTENS & WERMUTH 1960, etc.), none has tried, so far to make a comprehensive morphoanatomical study of the entire group, except for the much earlier work of COPE (1865a, b). More than a hundred years ago, of course, there were many less species involved and much less material to create the complicated situation that exists today.

The following definition represents the best compromise that we could reach, which is by no means definitive.

Definition: No cranial exostosis; maxillary and palatine teeth present; quadratojugal usually well developed; pectoral girdle arciferal; omosternum and sternal plate cartilaginous; sacral diapophyses usually dilated (except in a few large South American species); no backwards projecting process on the ischium; skin of the head not coossified with the skull (except in a few species from the West Indies); tongue slightly free or fused behind, entire or nicked; pupil horizontal; tympanum fairly distinct; toes webbed; last phalanges of fingers and toes dilated into larger or smaller discs, terminal phalanx hooked; tadpoles aquatic.

### *Hyla savignyi* Audouin, 1829

*Hyla savignyi* Audouin, 1829: 183, pl. 2, fig. 13. Type locality: Syria, by selection by FLOWER (1933: 735).
*Hyla arborea savignyi* Audouin. – Parker 1938: 492; Parker 1941: 6; Schmidt 1953: 256.
*Hyla savignyi* Audouin. – Schneider & Nevo 1972: 497; Arnold 1980: 276, 330.

Type material: Types not traced.

Other material (129 specimens; see map, fig. 15): 50: Abha, 18°13'N 42°30'E, 2120 m, BM(NH) 1938.2.1.115–119, HStJBP 12.VI.1938 (PARKER 1938). – 2: Migyal al Asad, 15°17'N 44°21'E, 2500 m, BM(NH) 1938.8.1.10-18, EBB 18.II.1938 (PARKER 1941). – 2: Migyal al Alaf, 15°14'N 44°13'E, 2300 m, BM(NH) 1938.8.1.19, EBB 24.II.1938 (PARKER 1941). – 2: Sana, 15°21'N 44°12'E, 2400 m, HH, REK 1951 (SCHMIDT 1953)[5]. – 3: 8 km W of Mabar, 14°48'N 44°12'E, 2400 m, HH, REK (SCHMIDT 1953)[5]. – 43: Barahara, 20°21'N 41°15'E, 1900 m, CAS 136516–527, JPG, RBF, RAF 11.IX.1973. – 44: Wadi Amaq, 21°21'N 40°17'E, 2000 m, CAS 139732–33, JPG 23.VIII.1974. – 45: Wadi Mahra, 19°38'N 41°54'E, 1910 m, CAS 145320–22, JPG 21.IV.1977; idem, CAS 145328, JPG 29.VI.1977; idem, CAS 145347, JPG 15.IX.1977; idem, BM(NH) 1978.901, HW IX.1978. – 4: Wadi Thareira, 21°09'N 40°44'E, 1440 m, IZUG JG 70805–06, JPG 27.V.1979. – 5: Wadi Shumruq, 20°29'N 41°20'E, 1500 m, IZUG JG 70804, JPG 27.V.1979. – 46: Bani Sar, 20°05'N 41°26'E, 2130 m, IZUG 70799–802, JPG 27.V.1979. – 45: Wadi Mahra (see above), IZUG JG 70788–790, JPG 28.V.1979. – 47: Bani Mashoor, 19°00'N 42°09'E, 2300 m, IZUG JG 70811–19, JG 70821–22, JG, MVA 6.VI.1979. – 50: Hijla, 18°18'N 43°28'E, 1900 m, IZUG JG 72417–18, AKN 25.X.1978; idem, IZUG JG 72419–22, AKN 17.VI.1979. – 46: Bani Sar (see above), BM(NH) JG 73003, JPG 10.VIII.1980; idem, BM(NH) JG 70931, 2 spcs, JPG 14.VIII.1980. – 49: Wadi Wajj, 21°08'N 40°14'E, 2000 m, IZUG JG 72488, ISC II.1980. – 47: Bani Mashoor (see above), IZUG JG 70895, 14 spcs, JPG 1./2.IV.1980. – 49: Wadi Hubaykah, 21°10'N 40°20'E, BM(NH) 1979.921, AAF early 1980. – 45: nr Al Alayyah, 19°37'N 41°57'E, 2000 m, IZUG JG 72487, 5 spcs, JPG 1.IV.1980. – 49: Jebel Dakka, 21°07'N 40°14'E, 2000 m, BM(NH) 1976.1709–12, GBP 22.VI.1962; idem, IZUG JG 72527, 11 spcs, JG 1980 (?). – 50: Abha (see above), BM(NH) 1976.1702–12, AAF 12.IV.1976. – 47: nr Bani Mashoor (see above), BM(NH) 1977.393–94, CHL 1977. – 50: "Waterfall Wadi", 18°14'N 42°24'E, 2500 m, BM(NH) 1977.395–98, CHL 22.IV.1977. – 50: Wadi Abha (= Abha, see above), BM(NH) 1977.399–404, CHL 12.VIII.1977. – 50: Hijla (see above), BM(NH) 1977.405, AKN 6.VII.1977; Al Asran (?), BM(NH)

1978.686–90, AKN c. 1977. – 45: Wadi Mahra (see above), BM(NH) 1978.901, JPG c. 1978 (?); nr Wadi Ahger (?), BM(NH) 1982.1139–40, KAB 20.III.1980. – 42: nr Amram, 15°38′N 43°50′E, 2300 m, MZUF 19984–93, MB 18.II.1984. – 50: Wadi Mahalla, 18°19′N 42°35′E, 1900 m, BM(NH) 1985.402–03, JLB 17.IV.1981. – 51: Dahna Shalal, 18°55′N 42°12′E, 2300 m, BM(NH) 1985.404, JLB 5.IV.1984. – 1: Wadi Jeman, 18°02′N 42°45′E, 2200 m, BM(NH) 1985.405, JLB 4.IV.1984. – 52: An Nimas, 19°07′N 42°08′E, 2000 m, BM(NH) (?), CHL 22.IV.1977. – 46: USGS nr Bani Sar (see above), BM(NH) 73004–05, RAF 1./2.VIII.1984. – 48: Al Khadra, 19°19′N 42°05′E, 2800 m, IZUG JG 72808, AKN 17.VI.1983. – 50: Al Mukadda, 18°14′N 42°25′E, 2500 m, BM(NH) JG 72658, 3 spcs, AKN 1.XII.1981.

Description: A small species of the Palaearctic group of *Hyla*, up to 47 mm long from snout to urostyle. Dorsal parts usually bright green, though variable with physiological conditions; bluish-green to olive-brown in alcohol. A darker, normally greyish-brown stripe, edged above and below by a yellowish-brown line, runs from the nostril through the eye and tympanum, to the groin, along the sides of the body. Another whitish line runs on the lips from the snout tip to the shoulder. The upper

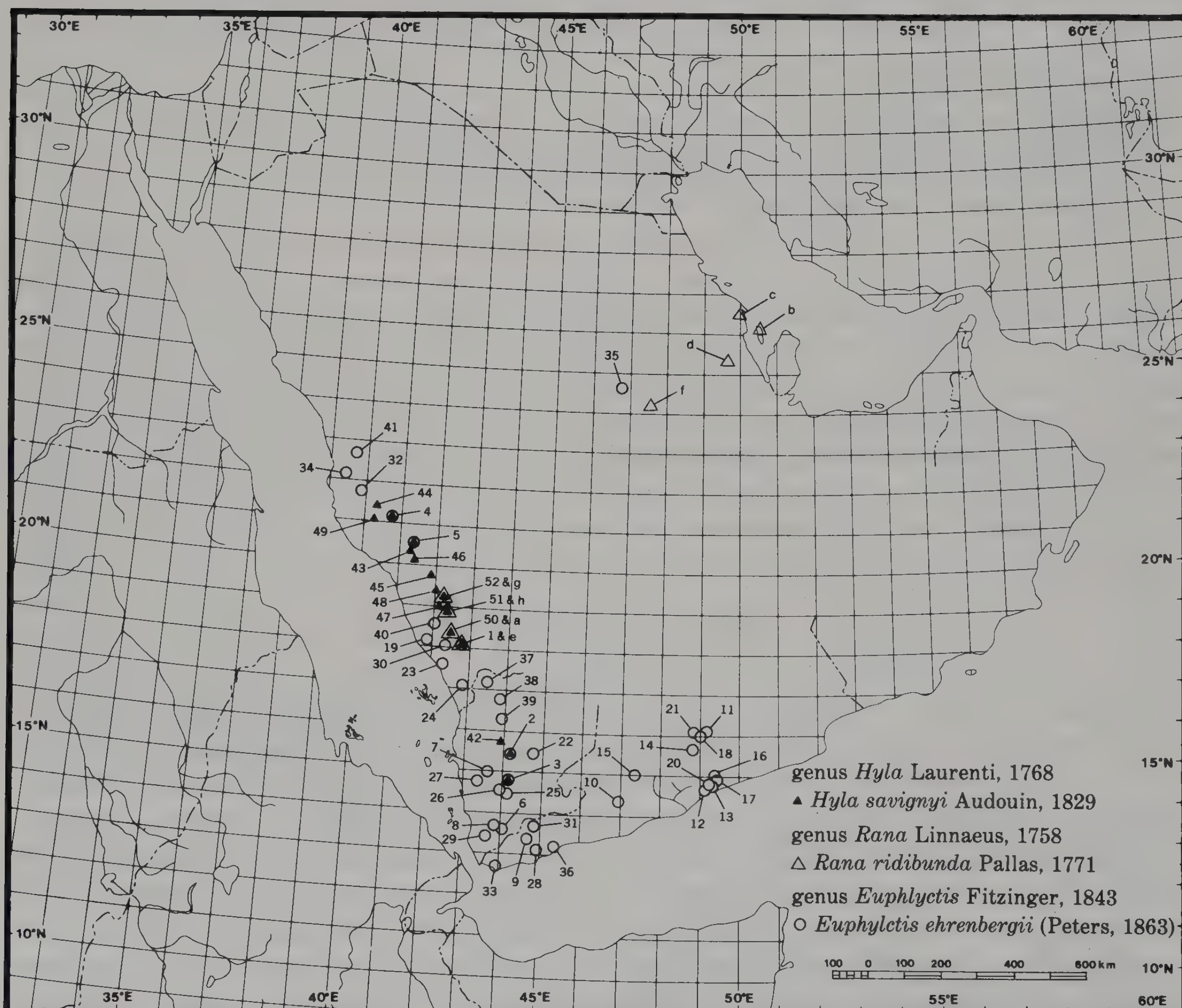



Fig. 15: Distribution of *Hyla savignyi*, *Rana ridibunda* and *Euphlyctis ehrenbergii*.

**Table 3: Characteristics of mating calls of three species of *Hyla*, showing species-specific characteristics of *Hyla savignyi*.**

| | *Hyla arborea* | | Hyla savignyi | | Hyla meridionalis | |
|---|---|---|---|---|---|---|
| | 10°C | 20°C | 10°C | 20°C | 10°C | 20°C |
| Call duration (ms) | 94.71 | 65.71 | 160.90 | 135.00 | 509.67 | 250.27 |
| Intercall interval (ms) | 163.52 | 81.62 | 215.09 | 173.29 | 1997.46 | 918.06 |
| Pulses per call | 0.09 | 0.09 | 20.42 | 19.42 | 44.38 | 34.48 |
| Calls per 15 s | 61.12 | 101.92 | 40.27 | 50.57 | 6.64 | 11.34 |

(ms = milliseconds; data from Schneider & Nevo 1972).

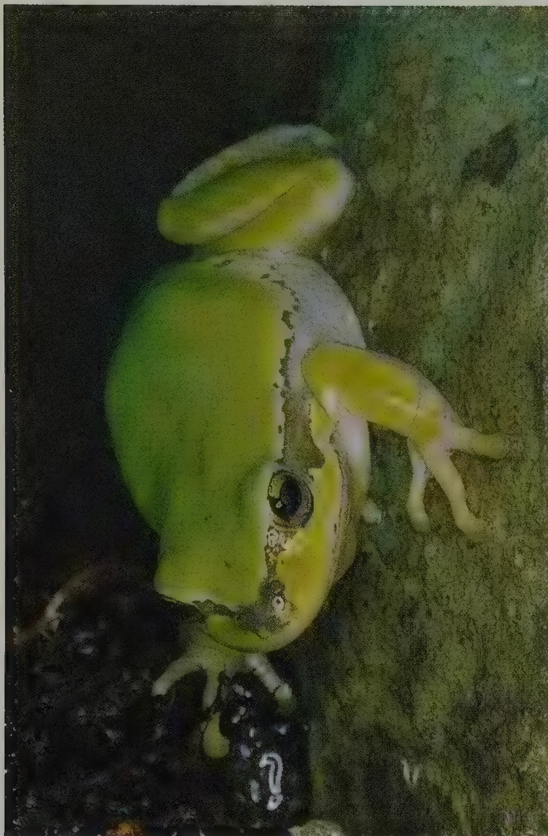
sides of the arms and legs, to the carpal and tibiotarsal articulations, respectively, have a stripe of the same colour as the upper parts of the body distinctly edged all around with a whitish and blackish line. The latter lines are thicker above the vent, where they form a distinct cross line. Some green shadings may occur on the carpus, tarsus, fingers and toes. Upperside skin smooth to granular. Underside white to yellowish white, more granulose on the belly than on the throat.

Head rather flat, canthus rostralis distinct, loreal regions flat to concave, snout truncate in lateral view, interorbital space about as broad as the upper eyelid, internarial distance slightly narrower. Tympanum distinct, diameter about half the eye diameter, distant from it by about half its own diameter. Vomerine teeth placed in two small oval groups between the choanae.

Hand with some rudimental webbing at the base of fingers, toes half to two-thirds webbed. Tips of fingers and toes swollen into small discs, two-thirds the size of the tympanum. Metatarsal tubercle prominent, small, its length being nearly equal to the diameter of the discs on the finger-tips. Legs rather long, extended forward along the body the tibio-tarsal articulation reaches the eye center, or more rarely its rear or front edge. When the legs are kept folded at a right angle to the longitudinal body axis, the heels normally overlap slightly, or touch each other in some cases. A distinct white margined fold along the inner edge of the tarsus.

Testes white.

Variation: Sexual dimorphism in *Hyla savignyi* is faint, the males being normally smaller than the females at maturity. Males average 33.4 mm (± 6.4) females 44.4 mm (± 2.2). The largest measured male is 42.0 mm long, the largest female 47.5 mm. The gular skin of the males is, on the average, slightly less granulose than in the females, but except in extreme cases, determination of sex requires dissection. Variations in colour pattern may occasionally involve the shape of the lateral dark bands. In some females, this streak may have an upwards and forwards expansion on the loin. Such a protrusion, that is rather similar to the colour pattern of *Hyla arborea,* is usually isolated posteriorly, from the lateral streak, by a white band. The lateral streak is normally less developed, posteriorly, than in *Hyla arborea* and in several specimens it does not reach the groin, or is resolved in a series of small, white circled spots, on the rear side. The variation in morphometric characters is not, on average, very pronounced and falls into the limits outlined in the diagnosis above. The head length is about 86% (± 0.04 S.E.M.) of its width; the internarial distance is aoubt 85% the width of the upper eyelid (± 0.2); the latter is 1.1% (± 0.6) the interorbital space; the horizontal diameter of tympanum measures 49% (± 0.15) that of the eye and is separated from the eye by a distance of about 65% (± 0.2) of the diameter of the tympanum. The tibia length is 46% (± 0.02) of the total body length and the length of the tarso-metatarsal segment is 59% (± 0.02) that of the tibia. The horizontal diameter of the disc at the apex of the third finger measures 83% (± 0.7) of the tympanum, and 0.97% (± 0.15) the length of the metatarsal tubercle.



11c

12

11a

11b

Plates 11–12: 11 a–c, *Hyla savignyi*; 12, *Rana ridibunda*.

Tadpole: So far as we were able to ascertain, the tadpoles of *Hyla savignyi* have never been described.

Biology: *Hyla savignyi* appears to breed mostly in perennial, preferably deep waters. The breeding season in Palestine (SCHNEIDER & NEVO 1972) starts in mid-December to mid-January, depending on the occurence of rain. Choruses of males continue up to mid-August, then they start to decline. In the Asir and Yemen the pattern of activity of this species appears to be slightly different. All the specimens that we studied were collected from September to late July. In the period between August and October Professor Scorteccii did not find any specimens of *Hyla,* although he searched in the localities where the species was known to occur (PARKER 1938, 1941; SCHMIDT 1953).

Mating call: During the mating season (SCHNEIDER & NEVO 1972), this species spends the day on trees or on bushes, moving to water at dusk. Choruses start a little before sunset and last nearly all night. *Hyla savignyi* may call when sitting on the banks or on objects floating in the water or when perched in bushes or other vegetation surrounding the breeding ponds. The mating call consists of a series of 15–50 chirps of 15–26 pulses, followed by a pause that varies in length from 200–500 ms. At the peak of the breeding activity the call sequence may consist of 100 chirps or more. Calling activity starts at an air temperature of 9°C and stops at 26°C. Increase in the air temperature produces a decrease both in call duration and in intercall intervals. SCHNEIDER & NEVO demonstrated that *Hyla savignyi* greatly differs in its mating call from either *Hyla arborea* or *Hyla meridionalis,* and that, it is intermediate in call parameters between the other two species, although closer to *Hyla arborea* (tab. 3). On the basis of their audio studies it is accepted that *Hyla savignyi* is, in fact, a distinct specific taxon.

Ecology: In Arabia *Hyla savignyi* is distributed from about 21°30′N southwards into Yemen to about 14°30′N seemingly restricted by altitude, i.e., rainfall and temperature. They inhabit the areas above 1400 m or the 400 mm isohyetal line, being more common at 2000 m and higher at the maximum isohyetal level, where there is perennial or semi-perennial water, lower temperatures and relatively good vegetation.

This little tree frog, like *Bufo viridis* and *Rana ridibunda,* appears to be a Palaearctic relict. In places where it is found it is usually quite numerous.

## Genus ***Rana*** Linné, 1758

*Rana* Linné, 1758: 210. Type species: *Rana temporaria* Linné, 1758: 212; by selection by FITZINGER (1843: 31).

*Ranairia* Rafinesque-Schmaltz, 1814: 102; replacement name for *Rana* Linné, 1758, being an unnecessary substitution.

"Palmirana" Ritgen, 1828: 278. Nomem nudum.

*Pelophylax* Fitzinger, 1843: 31. Type species: *Rana esculenta* Linné, 1758: 212.

*Crotaphitis* Schulze, 1891: 176. Type species: *Rana temporaria* Linné, 1758: 212; by selection by STEJNEGER (1907: 212).

*Baliopygus* Schulze, 1891: 177. Type species: *Rana esculenta* Linné, 1758: 212; by selection by STEJNEGER (1907: 212).

Nomenclature and systematics: The synonymy of the genus *Rana* is a complicated matter, which is not settled by the above list. Several other generic names were created in the past to designate possible taxa mostly from the Neotropical Region, of which we have little personal experience. As they are of little consequence for the purposes of the present work they are not treated here. Readers are referred to DUBOIS (1981) whose paper on the nomenclature of the Ranoidea presents a more exhaustive synonymic list. The Euro-Asiatic complex of the genus *Rana* represents a compact group of species, either from the osteological or the morphological point of view. In the rather unlikely case that the "water frogs" were deemed generically or subgenerically separate from the "brown frogs", the name *Pelophylax* Fitzinger would be available for the former group.

Osteology: The osteological features of the genus *Rana* in Africa were well described by Clarke (1981). The characters by which it differs from the genus *Euphlyctis,* the other Arabian genus of this family, are as follows (Clarke 1981): Nasals reduced, slip-like, widely separaged on the mid line; posterior medial frontoparietal ridge absent; zygomatic ramus of the squamosal as long or longer than the otic ramus; preorbital process of the maxilla well developed, rectangular; anterior end of the maxilla convex; pterygoid process of the maxilla absent to moderately developed; prevomeral processes short, widely separated from the maxilla/premaxillar articulation; cultriform process of the parasphenoid anteriorly rounded, with almost straight lateral borders; distal end of anterior pterygoid ramus overlapping dorsal surface of posterior lateral border of palatine; omosternum not forked; epicoracoid cartilages completely fused, coracoids not overlapping; distal ends of terminal phalanges of fingers and toes simple.

From the phylogenetic point of view, Clarke (1981) considers *Rana* to be very closely related to *Hylarana* and *Strongylopus;* both might be subjectively considered to represent subgenera of *Rana* itself. However, there is considerable opposition to acceptance of Dubois' (1981) concept of subgeneric divisions (Drewes, pers. comm.).

***Rana ridibunda*** Pallas, 1771

*Rana ridibunda* Pallas, 1771: 458. Terra typica restricta: Guryev, north coast of the Caspic Sea (Mertens & Müller 1928).

*Rana ridibunda* Pallas. – Parker 1938: 490; Loveridge 1955: 1; Haas 1957: 50; Haas 1961: 19; Eiselt & Schmidtler 1973: 222.

For a more detailed synonymic list for regions outside the Arabian peninsula see Gorham (1974).

Type material: Types not traced.

Other material (69 specimens; see map, fig. 15): a: Abha, 18°13'N 42°30'E, 2120 m, BM(NH) 1938.2.1.90–97, HStJBP 12.VI.1936 (Parker 1938). – b: Jidd Hafs, 26°13'N 50°32'E, NSL, CNHM (?), HF (Loveridge, 1955)[5]. – c: nr Dhahran (= Al Qatif) 26°36'N 49°58'E, NSL, CAS 84273, JG IX.1945 (Haas 1957); idem, CAS 84407–12, JG XII.1945 (Haas 1957); idem, CAS 84413, JG 23.VII.1946 (Haas 1957). – c: Al Qatif (see above), CNHM 74012, JG 24.VII.1946 (Haas 1957). – c: Qatif Oasis (= Al Qatif) (see above), CM 335549–51, RSM 14.V.1954 (Haas 1961)[5]; idem, CM 335544–46, RSM II.1953 (Haas 1961)[5]. – d: 5 km E Hufuf, 25°20'N 49°38'E, 150 m, CM 335547–48, RSM 20.IV.1953 (Haas 1961)[5]. – c: Qatif (see above), BM(NH) 1976.1731–34, 2 ♀♀ 2 juv., AAF V.1976; idem, BM(NH) 1983.367–70, 3 ♂♂ 1 ♀, WB 18.IX.1979. – d: Hufuf, 25°22'N 49°34'E, 150 m, BM(NH) 1963.808–10, 2 ♀♀ 1 juv., GBP 24.XI.1962; idem, BM(NH) 1953.1.8.26–29, 2 ♀♀ 2 juv., GBP 1950/1953 (Haas & Battersby 1959 as *Rana cyanophlyctis ehrenbergii*). – b: Sihlat al Hadriya, 26°12'N 50°32'E, NSL, BM(NH) 1971.137–38, ♂♂, MDG 15.I.1971. – b: Ras Sanad, 26°10'N 50°36'E, NSL, BM(NH) 1971.146, ♂, MDG 15.I.1971. – a: "Waterfall Wadi", 18°14'N 42°24'E, 2500 m, BM(NH) 1977.357–59, 2 ♀♀ 1 juv., CHL 22.IV.1977. – e: Wadi al Qaraah, 18°04'N 42°42'E, 2000 m, BM(NH) 1977.360, ♂, CHL 12.VIII.1977. – a: Wadi Abha (= Abha, see above), BM(NH) 1977.361–62, ♀♀, CHL 12.VIII.1977. – f: Al Kharj, 24°12'N 47°23'E, 430 m, BM(NH) 1978.709–11, ♂ ♀ juv., MAR c. 1977. – b: Bahrain (see above), BM(NH) 1937.7.18.1, SH, JF 2.IX.1969; Rub-al-Khali, desert (?), BM(NH) 1932.101.1–3, juvs, HStJBP 1932. – g: An Nimas, 19°07'N 42°08'E, 2250 m, IZUG JG 72832, AKN 20.X.1983. – b: Bahrain (see above), IZUG JG 73006–09, 2 ♀♀ 2 ♂♂, KAK XII. 1984. – a: Wadi Mahalla, 18°19'N 42°35'E, 1900 m, BM(NH) 1985.386–89, ♂♂, JLB 15.IX.1983. – h: Dahna Shalal 18°55'N 42°12'E, 2300 m, BM(NH) 1985.390–401, juvs, JLB 13.IX.1983.

Description: Arabian *Rana ridibunda* is a middle-sized (40–76 mm snout to urostyle) water frog, with brownish or greenish dorsal colour, irregularly blotched with large blackish spots on the back, cross bands on the arms and legs, and black marblings on the hinder side of thighs. Sometimes with

a coral pink vertebral stripe. The underside is white, more or less extensively marbled dark grey on the throat or even on the entire belly. Males have a couple of external grey or black vocal sacs, opening as irregular slits behind the mouth corners. A couple of rather prominent dorsolateral glandular ridges running from above the tympanum to the groin. A well developed tarsal fold along the inner edge of the tarso-metatarsal segment of the hind limbs. Vomerine teeth placed between the choanae. Lower jaw with three osolescent medial prominences.

Head convex, only slightly wider than long (lenght/width 0.82–0.95) triangular in general shape. Snout obtusely pointed, scarcely protruding beyond the mandible, sloping down forwards with a gentle curve. Tympanum distinct, circular to slightly pear-shaped, its horizontal diameter is about 68% (± 0.090) of the eye diameter, distant from the eye by 35–49% of the diameter of the tympanum. Interorbital space narrow, being 40–68% of the width of the upper eyelid.

Fingers pointed, scarcely dilated at apex, with well developed, prominent subarticular tubercles; the first finger is about as long as the second and 44–51% of the length of the whole hand. Hind limb well developed, its length (from tip of urostyle to tibio-tarsal articulation) is 70–86% of the entire body length (snout to urostyle); extended forward along the body the tibio-tarsal articulation reaches the eye. The tarsus measures 42–60% of the tibia length. Feet moderately large, their length totalling 57–64% of the length of the hind limb (to tibio-tarsal articulation) and 1.12–1.27 times as long as the tibia. Toes webbed to about ½ of the last phalange of digits I–III, V, and to the base of the third phalange on the IVth. Webbing accounts for 61–77% of the foot length. A single , inner, metatarsal tubercle, rather flattened and scarcely prominent in lateral view, measuring about 9–13% of the foot length and 27–36% of the first toe.

Variation: Arabian *Rana ridibunda* are represented by at least two geographically removed populations. One is found in the oases of Bahrain, Al Qatif and Al Hasa, and as far west as Al Kharj. The other population is found near Abha and An Nimas in the Asir at high elevations in a very different ecological environment. Biometrical differences between them appear to be rather obscure. Much more work is necessary to determine the relationship of the two populations and how they fit into the complicated *Rana ridibunda* complex. Sexual dimorphism is obvious enough. Males of *Rana ridibunda* are easily identified by their external vocal sacs and by the well developed callosity on the lateral and lower parts of the first finger. Size differences between mature specimens of the two sexes are not great. Males measure 40–58 mm from snout to urostyle, females 45–87.5 mm.

Tadpole: The tadpoles of the Arabian water-frog have not been described. However, Briggs (1981) studied *Rana ridibunda* in the Al Qatif oasis commencing in January 1980 continuing to mid-1983 (in litt.) and probably longer. He notes that metamorphosis occurs when the larvae are from 22–34 mm in length (average 25.7 mm) based on measurement of 43 fully metamorphosed frogs late December – early April.

Population biology: Briggs (1981) says that at Al Qatif the breeding season starts in November extending through January. Metamorphosis commences in January with a peak in late February continuing into the summer when a few slow-growing tadpoles finally mature. This breeding activity is spread over a much longer period than in northern populations. It is similar to that in Iran, where, according to Anderson (1963), the eggs are laid in late February and in March, most metamorphosis being completed by early April and finished in May. Anderson adds that attempts to induce autumn ovulation in females using injections of mammalian and reptilian anterior pituitary were unsuccessful.

Discussion: The current hypothesis found in the recent literature is that *Rana ridibunda,* together with *Rana lessonae,* represent a pair of parent species, the product of whose hybridisation would be the so called *Rana esculenta.* (See Günther 1979, for a short review). More recent studies did not confirm the existence of hybrid specimens or populations in Northern Italy and although the previous hypothe-

sis was mainly based on the central European situation, they cast some doubts on some of the results obtained by previous authors (BALLETTO et al. 1984, 1985). The situation in Northern Italy involves the existence of many small populations all of which show very high levels of genetic differentiation with respect to any other population, and it may well be that some, or even many of them, can qualify as separate semispecies or biospecies.

Although a detailed electrophoretic and biometric study such as was conducted in Northern Italy is not available, as yet, for the Arabian water frogs, there is indicative evidence of the possibility that southwest Asian populations of *Rana ridibunda* may behave along the same general lines. EISELT & SCHMIDTLER (1973) demonstrated that population of water frogs from Western Iran and Bahrain differ one from the other as well as from those of so-called ssp. *saharica,* on several biometrical characters such as the body size, the relative size of the head, tympanum, metatarsal tubercle and in the length of their legs.

Much more biological research is needed before the interesting problem represented by the mechanism of speciation enacted in this group of frogs, may become completely understood.

Ecology: Arabian *Rana ridibunda* live in two of the most diverse habitats in the peninsula. The eastern population is found in the oases of Bahrain, Al Qatif and Al Hasa, where it is the only known Amphibian species. A collection record from Al Kharj, about 100 km W of Al Hasa (like *Euphlyctis ehrenbergii* from Riyadh) is suspected to be a recent introduction, even though it is an identical habitat. The restricted distributional area outlined above, is in extreme desertic surroundings. Intense summer temperatures commonly exceed 45°C, minimum winter temperatures seldom drop to 0°C. Rainfall is on the order of 50–60 mm per annum. The *Rana* are confined to the oases where they live in huge hand dug wells and cisterns, irrigation ditches and drainage ditches and adjunct drainage swamps. They are sympatric with the pond turtle *Mauremys caspica* (Bahrain, Al Qatif and Al Hasa), that shares the same confinement as *Rana ridibunda.* Also in this habitat is the grey mongoose, *Herpestes edwardsi* (Bahrain and Al Qatif) and the Asiatic jackal *Canis aureus* (Al Qatif and Al Hasa). These faunal forms are probably relicts of western Asian invasions, now restricted to their well watered, extremely limited habitats. The western population of *Rana ridibunda* in Arabia is found in the high Asir (see *Bufo viridis,* Ecology). It is to be noted that the two known populations of *Rana ridibunda* in Arabia derived from two very widely separated invasions. Probably separated chronologically as well as geographically.

## Genus ***Euphlyctis*** Fitzinger, 1843

*Euphlyctis* Fitzinger, 1843: 31. Type species: *Rana leschenaultii* Duméril & Bibron, 1841: 342.
*Phrynoderma* Fitzinger, 1843: 31.Type species: *Rana cutipora* Duméril & Bibron, 1841: 338.
*Limnonectes* Fitzinger, 1843: 31. Type species: *Rana kuhlii* Duméril & Bibron, 1841: 384.
*Dicroglossus* Günther, 1860: 158. Type species: *Dicroglossus adolfi* Günther, 1860: 158.
"Hydrostentor" Fitzinger, 1860: 414 (nomen nudum).
*Hoplobatrachus* Peters, 1863a: 449. Type species: *Hoplobatrachus ceylanicus* Peters, 1863a: 449.
*Fejervarya* Bolkay, 1915: 181. Type species: *Rana limnocharis* Boie, 1829: 42; by designation by DUBOIS (1981: 238).
*Ranosoma* Ahl, 1924: 250. Type species: *Ranosoma schereri* Ahl, 1924: 250.

Nomenclature and systematics: The author who first saw the necessity of separating this relatively small genus from BOULENGER'S (1882a, 1918, 1920a, 1920b) all purpose genus *Rana,* was DECKERT (1938) in his important, albeit little known, paper on the osteology of the Ranidae. In his unpublished manuscript on African *Rana,* Boulenger (CLARKE 1981) had recognised that *Rana occipitalis* Günther, 1858 was closest to the Asian species *Rana hexadactyla* Lesson, 1834. Yet he did not grant this group

any real taxonomic status and later referred to it as "*Rana beccarii* (now *Conraua*) and its allies" (see CLARKE 1981). DECKERT (1938) being apparently unaware of FITZINGER's work, made use of GÜNTHER's (1860) name *Dicroglossus*. The type species of this genus, though, *Dicroglossus adolfi* Günther, is now held as a subjective synonym of *Rana cyanophlyctis* Schneider. *Dicroglossus* is, therefore, placed in the synonymy of *Euphlyctis*, as the type species of the latter. *Rana leschenaultii* Duméril & Bibron, is currently considered to represent a junior subjective synonym of *Rana hexadactyla* Lesson, 1834, a congeneric of *Rana cyanophlyctis*.

It is to be noted, though, that choosing *Euphlyctis* instead of *Phrynoderma*, rests only on DUBOIS' (1975) action as first reviser, in accordance with Art. 24(a) of the ICZN, and not, as DUBOIS apparently thought, because it had been published earlier. Both names, in fact, were published by the same author in the same book, and bear the same date, 1843; and, the ICZN does not recognise any line (or even page) priority, stating "relative precedence is determined by the first reviser". Before DUBOIS' (1975) paper, therefore, either name was equally eligible for use to designate this taxon.

On taxonomic grounds it is to be stressed that *Limnocharis* Fitzinger, 1843 might represent a subgenus of *Euphlyctis*. Alternatively, the two names might also be used to designate two subgenera of *Rana*, as is maintained by DUBOIS (1975, 1981: 233). *Fejervarya* Bolkay may be another subgenus of *Euphlyctis* (DUBOIS 1981: 240–241). Our preference for the systematic framework adopted here rests mainly on CLARKE's (1981) phylogenetic conclusions supported by our osteological investigations. The only alternative solution, of course, would be that of considering, as BOULENGER did (1882a, 1918, 1920a, 1920b, etc.) a huge genus *Rana*, that would include the entire subfamily Raninae. It goes without saying, however, that considering a taxon at generic, rather than at subgeneric level, rests on purely subjective grounds.

Osteology: *Euphlyctis* (as *Dicroglossus*) was first separated from genus *Rana* (s.l.) by DECKERT (1938), mostly on the basis of it having epicoracoidal cartilages of "archizonal type" in their pectoral girdle, together with a proximally forked omosternum. TRUEB (1973) being unaware of DECKERT's paper, rediscovered this character of the epicoracoids for three species of *"Rana"*: the African *Rana occipitalis* Günther, and the Asian *Rana rugulosa* Wiegmann and *Rana tigerina* Daudin. Accordingly she described it under the slightly misleading name of "arciferal-like condition". DUBOIS (1974), on the basis of a former paper by LAURENT (1950) and of DECKERT's (1938) work, made use of the name *Dicroglossus* for a group of Nepalese frogs, granting them a subgeneric status. In this same work, however, he split *Dicroglossus* into two subsets: "Groupe de *Rana (Dicroglossus) hexadactyla*" and "Groupe de *Rana (Dicroglossus) tigerina*", thus partly reflecting the classification formerly produced by BOULENGER (1920a) ("Ranae hexadactylae" and "Rana tigrinae"). Such classification was mostly supported by features of the external morphology. The first group (BOULENGER's "hexadactylae") have a more prominent, digitate, metatarsal tubercle, more extensively webbed feet, with a reduced fourth toe, a larger and more deeply cleft tongue, the persistence of a rudimentary lateral line system in the adults, beside some ecological and ethological characters that separate them from the "*tigerina*". The general appearance of the skull of the frogs of the group of *Rana hexadactyla* would be more similar to that of *Rana* (s.str.).

CLARKE (1981), dealing with the evolutionary relationships among the African Raninae, studied osteological details at greater depth and came to the conclusion that *Euphlyctis* derives from a source rather removed from that of *Rana* (s.str.). The "pseudo-arciferous" condition, here interpreted as a plesiomorphic character, is however shared by five African genera (*Pyxicephalus, Aubria, Conraua, Euphlyctis* and *Tomopterna*), although the latter is probably closer to the lineage of *Rana* (reduced nasal bones, etc.). The four remaining genera share several derived characters including a posterior frontoparietal ridge; a fully developed otic plate; distal ends of terminal phalanges rounded and "mushroom-shaped". They are accordingly considered to form a clade. *Euphlyctis*, in particular, could

represent the sister group of *Conraua,* from which it differs mostly by having two uniquely derived characters, reduced anterior prevomeral processes and confluent cervical cotyles. CLARKE's conclusions on this subject were mainly based on skeletal preparations of the only African representative of the genus, *Euphlyctis occipitalis* Günther, but also on the type species of the genus, *Euphlyctis cyanophlyctis* (Schneider), and on *Euphlyctis tigerina* Daudin, at least in so far as some characteristics were concerned (CLARKE 1981: 317, see also BOULENGER 1920a: 11, 13). We considered it of some interest, therefore, to proceed with a comparative study of the osteology of the Arabian representative, *Euphlyctis ehrenbergii* (Peters).

All skeletal features previously utilised by CLARKE (1981) are shown in fig. 16 for a mature female from Al Ghuraf. 15°59'N 48°59'E, 640 m. It differs from that of *Euphlyctis occipitalis* in the following features (3 skeletons examined):

1. The degree of development of the otic plate of the squamosal bone shows bilateral variability, it being partially fused with the otoccipital on the right side and smaller, just overlapping in dorsal view the crista parotica and lateral border of the otoccipital, on the left. On average the general impression is that this feature should be referred to character state 0 (see CLARKE 1981) rather than 1.
2. The cervical cotyles of the first vertebra are narrowly but clearly separated by an intercotylar groove. This character state (again 0 rather than 1) contrasts with CLARKE's findings for *Euphlyctis occipitalis* and *Euphlyctis tigerina.*
3. The omosternum of *E. ehrenbergii* is broadly bifurcate at the mesial end.

These observations, on the one hand, are in no sharp contrast with the overall scheme of evolutionary relationships existing among the Raninae, as proposed by CLARKE (which can be updated with only a few minor modifications; see also SHIZOMANY 1950), and provide further evidence of the close relationship existing between *Euphlyctis* and *Conraua,* on the other (see LAMOTTE & PERRET 1968). It seems therefore reasonable enough to infer that *Conraua* represents the outcome of an ancient African radiation of the "euphlyctine stock" of the Raninae, while *Rana occipitalis* may well derive from a more recent invasion. Deciding whether or not *Conraua* would be considered a subgenus of *Euphlyctis* or generally distinct from it, may of course, be a matter of a rather subjective nature. Tadpoles of the two species are very different. The diagnosis of genus *Euphlyctis* (s.str.) should, however, be changed as follows (from CLARKE 1981, modified):

Diagnosis: Nasals large, triangular, in broad medial contact; no cranial exosteosis; posterior medial frontopariental ridge present; occipital canal absent; otic plate present, overlapping the crista parotica and a variable extent of the otoccipital bone; zygomatic ramus longer than the otic ramus, well separated from the maxilla; preorbital process of the maxilla reduced anteriorly, almost triangular in lateral view; anterior end of maxilla deeply concave; pterygoid process of maxilla slightly overlapping or abutting anterior ramus of the pterygoid; anterior process of prevomer moderate or long, separated or not from mesial maxilla-premaxilla articulation by a short gap; palantines present; anterior end of parasphenoid cultriform process pointed, tapering from level of sphenethmoid; distal end of anterior pterygoid ramus separated from posterior lateral border of palatine by a short gap; mesial ramus of pterygoid overlapping ⅕–¼ lateral width of anterior border of parasphenoid ala, in the anterior/posterior plane; cervical cotyles distinct, narrowly separated by an intercotylar groove, or confluent; omosternum moderately to broadly forked at base; clavicles straight, horizontal, nearly meeting in the midline; epicoracoid cartilages partially free and overlapping medially; sternal style short, flat ossified cartilaginous or bony plate; 8th presacral and sacral vertebrae not fused; dorsal protuberance of ilium large, differentiated from, and situated on, dorsal prominence, confluent with dorsal ilial crest; distal ends of terminal phalanges of fingers and toes rounded, with slight lateral expansions ("mushroom-shaped").

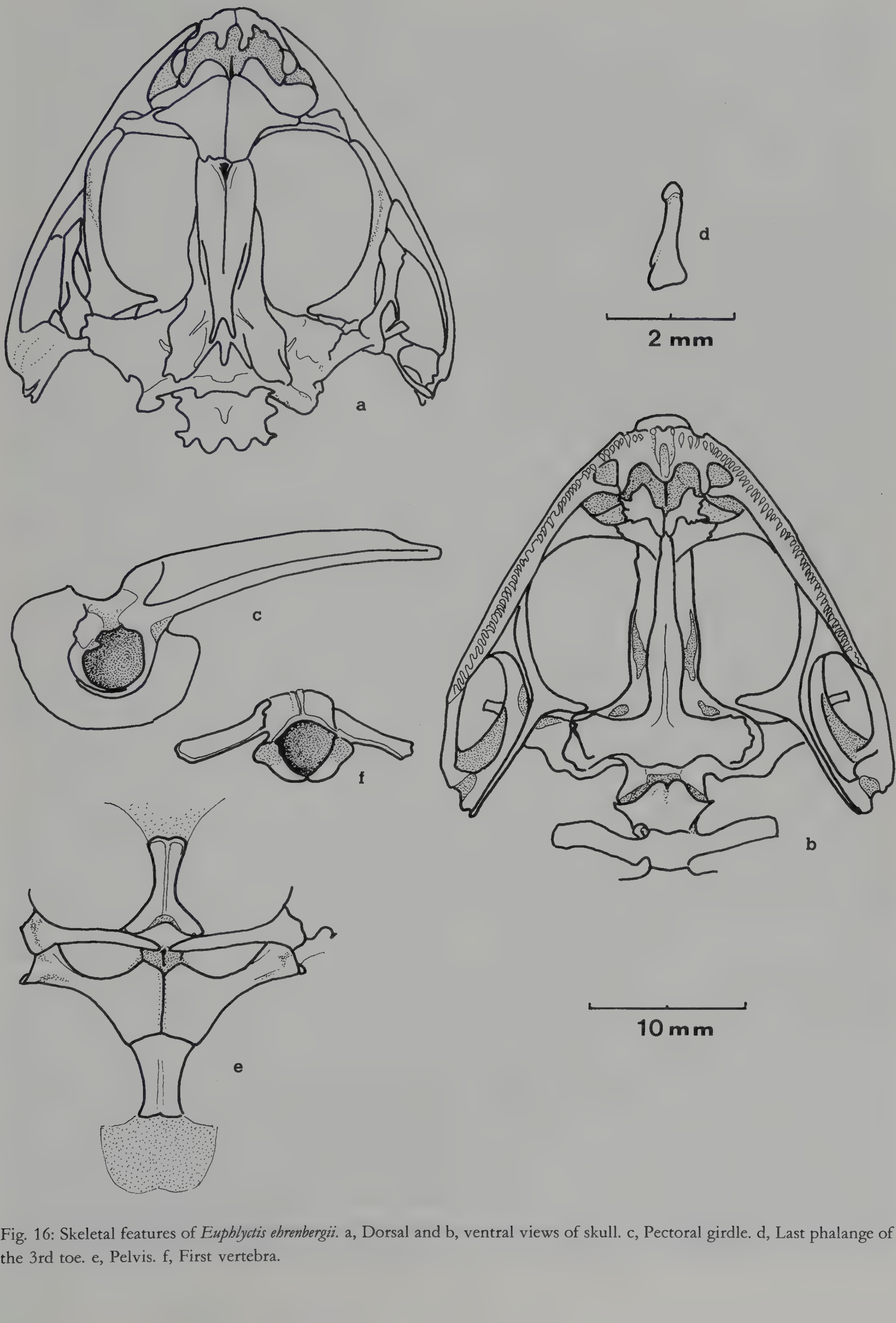



Fig. 16: Skeletal features of *Euphlyctis ehrenbergii.* a, Dorsal and b, ventral views of skull. c, Pectoral girdle. d, Last phalange of the 3rd toe. e, Pelvis. f, First vertebra.

***Euphlyctis ehrenbergii*** (Peters, 1863b).

*Rana ehrenbergii* Peters, 1863b: 79. Type locality: "Arabia".
*Rana ehrenbergii* Peters. – Boulenger 1882a: 18; Matschie 1893: 31.
*Rana cyanophlyctis* Schneider, 1799: 137.– Boulenger 1882b: 110; Boulenger 1890: 442; Anderson 1895: 660; Steindachner 1900: 335; Anderson 1901: 152; Steindachner 1903: 11; Boulenger 1920a: 12–15.
*Rana cyanophlyctis ehernbergii* Peters. – Parker 1941: 5; Schmidt 1953: 256; Haas & Battersby 1959: 198; Arnold 1980: 276.
*Rana (Dicroglossus) cyanophlyctis ehrenbergii* Peters. – Dubois 1974: 379.

Type material: Types not traced. "Arabien", Hemprich & Ehrenberg (PETERS 1865)[5]. Probably from the vicinity of Al Qunfidah, 19°30′N 42°00′E.

Other material (595 specimens, approx. 220 larvae; see map, fig. 15): Tes (probably Taizz), BM(NH) 82.9.2.7.1, ♂, GD 1880. – 28: Lahadsch (= Lahij), 13°04′N 44°53′E, 150 m, ON 1892 (MATSCHIE 1893)[5]. – 28: Haithalhim, 13°06′N 44°53′E, 200 m, BM(NH) 95.5.23.91–100, JWY 1895 (ANDERSON 1895). – 28: Lahij (see above), (STEINDACHNER 1900)[5]. – Hadramaut (?), BM(NH) 97.3.11.120–27, larvae, JTB (ANDERSON 1901). – 36: Abyan, 13°10′N 45°20′E, 50 m, BM(NH) 99.12.13.92, ♂, HBP c.1899 (ANDERSON 1901); Azzam (?), OS c. 1902 (STEINDACHNER 1903)[5]. – 9: Azraki Ravine, 13°22′N 44°39′E, 550 m, BM(NH) 1903.1.2.8.17–19, ♂♂, GWB c. 1903. – 31: Mafari, 13°40′N 44°40′E, 1370 m, BM(NH) 1903.3.6.55–56, ♀♀, GWB c. 1903. – 31: Dhala, 13°42′N 44°43′E, 1460 m, BM(NH) 1937.11.1.1–2, larvae, BFH IX.1936. – 33: Wadi Timnan, 12°36′N 44°00′E, NSL, BM(NH), 2 larvae, PWRP 14.II.1940 (PARKER 1941). – 6: Usaifira, 13°35′N 44°02′E, 1370 m, BM(NH) 1938.8.1.1–3, 1 ♀ 2 ♂♂, EBB XII.1937 (PARKER 1941). – 7: Wadi Siham, 14°59′N 43°32′E, 475 m, CNHM, HH, REK 1951 (SCHMIDT 1953)[5]. – 6: Taizz, 13°34′N 44°02′E, 1370 m, CNHM, HH, REK 1951 (SCHMIDT 1953)[5]. – 8: Wadi Rissian nr Hajdah, 13°35′N 43°49′E, CNHM, HH, REK 1951 (SCHMIDT 1953)[5]. – 3: Mabar, 14°48′N 44°17′E, 2400 m, CNHM, HH, REK 1951 (SCHMIDT 1953)[5]. – 3: Wadi Mal-el-Ghail, 14°48′N 44°10′E, Birket-el-Thalama, 14°47′N 44°12′E, 2000–2400 m, CNHM, HH, REK (SCHMIDT 1953)[5]. – 10: nr Yashbum, 14°19′N 46°56′E, 1200 m, BM(NH) 1951.1.2.40–44, 1 larva, GBP 1950/1953 (HAAS & BATTERSBY 1959). – 11: Wadi Masila, 16°08′N 49°06′E, 750 m, IZUG, 4 ♀♀ 4 juv., GS spr. 1962. – 12: Hebis, 14°38′N 49°09′E, 150 m, ♀ ♂ 2 juv., GS spr. 1962. – 13: Ghayl Ba Wazir, 14°47′N 49°22′E, 60 m, IZUG, 3 ♀♀ 11 ♂♂ 1 juv. 4 larvae, GS 14.III.1962; Heian Hasseida (?), IZUG, 1 ♀ 3 ♂♂ 4 juv. 1 larva, GS 27.III.1962. – 14: Ghayl Omar, 15°44′N 48°52′E, 750 m, IZUG, 1 ♀ 3 ♂♂ 27 juv. 1 larvae, GS spr. 1962. – 12: Dis, 14°32′N 49°08′E, NSL, IZUG, 6 ♀♀ 1 ♂ 1 juv., GS spr. 1962. – 15: Al Maber, 15°02′N 47°17′E, 1500 m, IZUG, 2 ♀♀ 1 larva, GS 21.III.1962. – 16: Mahdi, 14°59′N 49°22′E, 1000 m, IZUG, 10 ♀♀ 11 ♂♂, GS spr. 1962. – 17: Wadi Taleh, 14°53′N 49°28′E, 150 m, IZUG, 2 juv. 2 larvae, GS 2.V.1962. – 18: Al Ghuraf, 16°00′N 48°59′E, 640 m, IZUG, 4 ♀♀ 1 ♂ 13 juv., GS 6.IV.1962. – 18: Heid Gassim, 15°56′N 49°00′E, 610 m, IZUG, 1 juv., GS spr. 1962. – 20: Dek Dik, 14°40′N 49°15′E, NSL, IZUG, 1 juv. 3 larvae, GS 15.III.1962. – 17: Al Barak, 14°55′N 49°24′E, 450 m, IZUG, 20 ♀♀ 12 ♂♂ 4 juv. 3 larvae, GS 29.III.1962. – 17: Al Nuima, 14°53′N 49°28′E, 450 m, IZUG, 8 ♀♀ 12 ♂♂ 20 juv., GS 28.III.1962. – 21: Gedda, 16°01′N 48°51′E, 760 m, IZUG, 6 ♀♀ 2 ♂♂ 1 juv., GS 17.IV.1962; Wadi Meifa (?), BM(NH) 1963.861, MAK, MW c. 1963. – 22: Wadi Harrah, 15°27′N 44°38′E, 2100 m, BM(NH) 1963.806, GBP 3.VIII.1962; Wadi Sahama (?), BM(NH) 1963.807, GBP c. 1962. – 23: Wadi Samra, 17°34′N 42°24′E, 50 m, CAS 102376–380, JG 29.IV.1965. – 24: Hakimah, 17°01′N 42°50′E, 80 m, CAS 140405, PDM 1974; Wadi al Gaddan (?), IZUG, 1 ♂, GS 16.VIII.1965. – 8: Rasyan, 13°38′N 43°46′E, 850 m, IZUG, 22 ♀♀ 9 ♂♂ 6 juv., GS 6.X.1965; Heioran (?), IZUG, 1 ♂, GS 10.X.1965. – 26: Medinat al Abid, 14°39′N 43°57′E, 1300 m, IZUG, 1 ♀ 3 ♂♂, GS VIII.1965. – 25: Hammam Ali, 14°36′N 44°09′E, 1600 m, IZUG, 13 ♀♀ 10 ♂♂, GS 6.–8.IX.1965. – 26: Wadi Rimah, 14°39′N 43°57′E, 1450 m, IZUG, 2 ♀♀ 4 ♂♂ 4 juv., GS 15.X.1965. – 27: Sukhnah, 14°48′N 43°26′E, 350 m, IZUG, 32 ♀♀ 18 ♂♂ 10 juv., GS VIII.1965. – 6: Usaifira (see above), IZUG, 7 ♀♀ 2 ♂♂, GS 28.VIII.1965. – 7: Wadi al Kasaba, 14°56′N 43°29′E, 1200 m, IZUG, 11 ♀♀ 6 ♂♂ 4 juv., GS 24.VIII.1965; Wadi Reilamah (?),

500 m, IZUG, 1 ♀, GS 10.IX.1965; Harrastein (?), IZUG, 9 ♀♀ 12 ♂♂ 8 juv., GS sum. 1965. – 29: Wadi al Bahr, 13°26'N 43°42'E, 500 m, IZUG, 5 ♀♀ 3 ♂♂, GS 2.VIII. 1965. – 30: Wadi Hiswa, 18°02'N 42°19'E, 800 m, CAS 70738–40, BM(NH) 1978.888–89, JG, PM 5.XII.1978; Wadi Garan (?), BM(NH) 1976.1729–30, AAF c. 1976. – 4: Wadi Thereira, 21°09'N 40°45'E, 1440 m, BM(NH) 1979.632–33, RAF 5.XI.1979; idem, BM(NH) 1980.34–37, JPG, SBH 12.VII.1979; idem, BM(NH) 1980.94–96, JPG 9.VI.1970. – 32: Al Jamum, 21°38'N 39°48'E, 200 m, BM(NH) 1979.920, larva, AAF early 1980. – 5: Wadi Shumruq, 20°29'N 41°19'E, 1600 m, IZUG JG 73010, PRG, BGS 13.VI.1980. – 34: Wadi Marwan, 22°10'N 39°22'E, 200 m, IZUG JG 72840–42, LH, EH 14.IV.1983. – 35: Riyadh, 24°38'N 46°43'E, 620 m, IZUG JG 72844–46, ISC 14.III.1984; Saudi Arabia (?), BM(NH) 1982.230 ?. – 2: Al Shallal, 15°21'N 44°12'E, BM(NH) 1982.1138, ♀, KAB, MAS 11.IV.1980. – 37: Jebel Nefah, 17°07'N 43°34'E, 1950 m, MZUF 1983/10.14586–96, 3 ♀♀ 2 ♂♂ 4 juv. 2 larvae, BM, MP 11.X.1980; idem, MZUF 1983/10.14571–85, 2 ♂♂ 7 juv. 11 larvae, MB, MP 16.VI.1981. – 38: Jabal al Khattarin, 16°44' 43°49'E, 1980 m, MZUF 1983/10.14486–87, juvs, MB VI.1981. – 37: Wadi ar Akua, 17°12'N 43°31'E, 1950 m, MZUF 1983/10.14248–78, 6 ♀♀ 6 ♂♂ 15 juv. 4 larvae, BL, MB, MP 19.XI.1979, 14.IX.1980, 24.VI.1981. – 37: 34 km NW Saadah, 17°10'N 43°33'E, 1950 m, MZUF 1983/10.14376–80, 4 juv. 1 larva, MZUF 1983/10.14381–84, 4 juv., MZUF 1983/10.14385–400, 2 ♀♀ 1 ♂ 13 juv., BL, MB, MP XI.1979, 8.IX.1980, 17.VI.1981. – 39: nr Al Ashshah, 16°14'N 43°53'E, 1200 m, MZUF 1983/ 10.14448–55, 1 ♀ 7 juv., MB, MP 26.VI.1981; btwn Umm Laylah (17°17'N 43°27'E) and Bagim (?), MZUF 1983/10.14569–70, 1 ♀ 1 ♂, MB, MP 15.VI.1981. – 37: Wadi Ar Akua (see above), MZUF c. 14276–78, 1 ♀ 1 juv. 8 larvae, MZUF c. 14248–53, 2 ♀♀ 3 ♂♂ 1 juv., MZUF c. 255–258, 1 ♂ 3 juv., BL, MB, MP XI.1979, IX.1980, VI.1981. – 37: Wadi Mahdi, 17°05'N 43°33'E, 1950 m, MZUF c. 14372, 12 larvae, MB, MP 10.IX.1980. – 41: Wadi Sitarah, 22°43'N 39°46'E, 670 m, IZUG JG 73011, 2 ♀♀ 1 ♂ 4 larvae, AHLL, ISC 10.III.1984. – 32: Tarfa, 21°42'N 39°53'E, 285 m, IZUG JG 72787, ♀, KGE 15.IV.1983; idem, IZUG JG 72810, ♂, WB 19.IV.1983. – 19: Rijal Alma, 18°09'N 41°54'E, 450 m, IZUG JG 73012, 1 ♀ 1 juv., AKN 2.III.1984. – 40: 5 km S Al Muhayl, 18°30'N 42°04'E, 850 m, IZUG JG 73013, ♀, AKN III.1984. – 1: 7 km S Al Qaraah, 18°00'N 42°42'E, 2200 m, IZUG JG 72830, juv., AKN 21.X.1983. – 41: Wadi Sitarah (see above), IZUG JG 73014, juv., AHLL, RS 22.XI.1984. – 34: Umm Addar, 22°10'N 39°32'E, 150 m, JG 72812–13, 8 ♀♀ 1 juv., WB 1.II.1983. – 34: Wadi Marwan (see above), IZUG JG 72811, 1 ♀ 1 ♂ 1 juv., WB 4.III.1983.

Description: A large, stout frog with a very dark, often almost black dorsal colour (in alcohol) which only rarely may turn lighter, mottled brown or black. In life from light green to dark green to blackish green, mottled darker. Underside pearl-white, extensively marbled dark brown on the throat in the adults of both sexes, and on the belly particularly of the largest females. The males have a couple of external, dark vocal sacs opening as two slits placed medially from the mandible, beneath the angles of the mouth.

Lower jaw with three tooth-like medial prominences. Head broad, flattened, widely triangular in general shape, distinct with a rather indistinct canthus rostralis. Tympanum distinct, circular, its diameter about two-thirds (65–70%) the horizontal diameter of the eye, rather distant from the eye, 42–60% the size of the tympanum. Interorbital space 60–70% the width of the upper eyelid, posteriorly marked by a more or less distinct cross fold. Vomerine teeth in two very small oblique series placed behind the inner openings of the choanae, commencing close to their inner margin. Fingers pointed, ending in a very small terminal disc. Hind limb rather short, its length measured from the tip of urostyle to the tibio-tarsal articulation, being 80–90% the body length (snout to urostyle); being extended forward along the body the tibio-tarsal articulation reaches the anterior edge of the tympanum in largest females, to the middle of the eye in juveniles. Feet large, typical of a species with aquatic habits, their length from tibio-tarsal articulation to tip of fourth toe about 87% of that of the entire limb (tip of

13c

13d

13a

13b

Plates 13 a–d: *Euphlyctis ehrenbergii.*

| Table 4: | *Euphlyctis ehrenbergii* | | | | *Euphlyctis cyanophlyctis* | | | |
|---|---|---|---|---|---|---|---|---|
| | ♂♂ (n = 58) | | ♀♀ (n = 66) | | ♂♂ (n = 32) | | ♀♀ (n = 16) | |
| 1 | 54.2 | (6.8) | 64.7 | (15.0) | 44.3 | (5.9) | 53.7 | (8.7) |
| 2 | 19.8 | (2.4) | 25.1 | (5.3) | 16.5 | (2.2) | 19.3 | (3.5) |
| 3 | 18.9 | (6.2) | 20.8 | (5.9) | 14.2 | (1.5) | 17.1 | (2.5) |
| 5 | 2.5 | (0.5) | 3.2 | (0.7) | 1.7 | (0.3) | 2.1 | (0.4) |
| 6 | 4.1 | (0.7) | 4.6 | (0.6) | 3.5 | (0.5) | 3.6 | (0.6) |
| 7 | 4.3 | (0.5) | 5.0 | (0.7) | 4.5 | (0.5) | 4.8 | (0.6) |
| 8 | 6.3 | (0.8) | 7.2 | (0.8) | 5.6 | (0.6) | 5.9 | (0.8) |
| 9 | 3.9 | (0.5) | 4.9 | (0.8) | 3.0 | (0.6) | 3.6 | (0.7) |
| 16+17 | 47.4 | (5.7) | 55.9 | (8.9) | 38.6 | (3.7) | 47.6 | (6.9) |
| 18 | 3.1 | (0.4) | 3.6 | (0.6) | 2.5 | (0.5) | 3.4 | (1.6) |
| 20 | 39.7 | (4.3) | 47.1 | (5.7) | 31.0 | (2.6) | 36.5 | (5.9) |
| 21 | 1.9 | (0.5) | 3.0 | (0.9) | 0.8 | (0.4) | 1.3 | (0.6) |
| 7/8 | 0.7 | (0.1) | 0.7 | (0.1) | 0.8 | (0.1) | 0.8 | (0.1) |
| 21/7 | 0.5 | (0.1) | 0.7 | (0.1) | 0.2 | (0.1) | 0.3 | (0.1) |

Some biometrical measurements (means, standard errors in brackets) taken on adult specimens of *Euphlyctis ehrenbergii* (South Yemen Arab Republic) and *Euphlyctis cyanophlyctis* (several localities from Afghanistan to the Malay Peninsula). Characters numbered as in fig. 1. Character 18 refers, in this case, to the length of the inner metatarsal tubercle. The ratio 21/7 (distance from eye to tympanum/max. diameter of tympanum) represents the most important diagnostic character.

urostyle to tibio-tarsal articulation), in both sexes. Toes are webbed to the tip of last phalanges, that are slightly dilated into a small disc. A single, inner, metatarsal tubercle, that measures about half the diameter of the eye.

The means and standard errors of some biometrical measurements taken on a series of specimens (58 ♂♂ 66 ♀♀) from South Yemen Arab Republic are given in tab. 4.

Variation: Apart from the morphological and biological differences between sexes reported below, Arabian frogs show conspicuous differences in their overall aspect and colouring, culminating in the manifestation of two extreme phenotypes, particularly visible in live specimens (G. Scortecci, personal communication). The first phenotype is characterized by strongly verrucose dorsal parts, with large, obtuse warts and conspicuous pores of the granular glands. The colouring in life is dark olive-brown or olive-green and yellow on the belly, often with large brown markings. The second phenotype is characterised, on the contrary, by an almost smooth dorsum, dark brown in colouring, and a white underside. The two phenotypes, however, are normally present together in most populations and linked by intermediates. Adult males of *Euphlyctis ehrenbergii* are easily distinguished from females by their external vocal sacs as well as smaller dimensions. The size varies; for males, from 40.2 to 84.0 mm (snout tip to urostyle), in females, from 56 to 109 mm (in a specimen from Rasyan; 107 mm in another from Wadi Al Kasaba). Males also have longer, narrower heads than females, the head length (mouth corner to tip of snout) totalling about 95% of its width (between the mouth corners), and only more than 80% of it in the females. The head length is 36% of total body length in males, and 32% in females. Although the dimensions of the tympanum are comparatively equal in both sexes, in the males, the eardrum is set closer to the eye than in the females. The distance between the eye and tympanum is about 44% of the tympanum diameter in males and 60% in females. The interorbital space is also wider in the females than in males, averaging 69% of the width of the upper eyelid in the former and only 60% in the males. Adult females are also, as a rule, more extensively marbled dark brown on the belly.

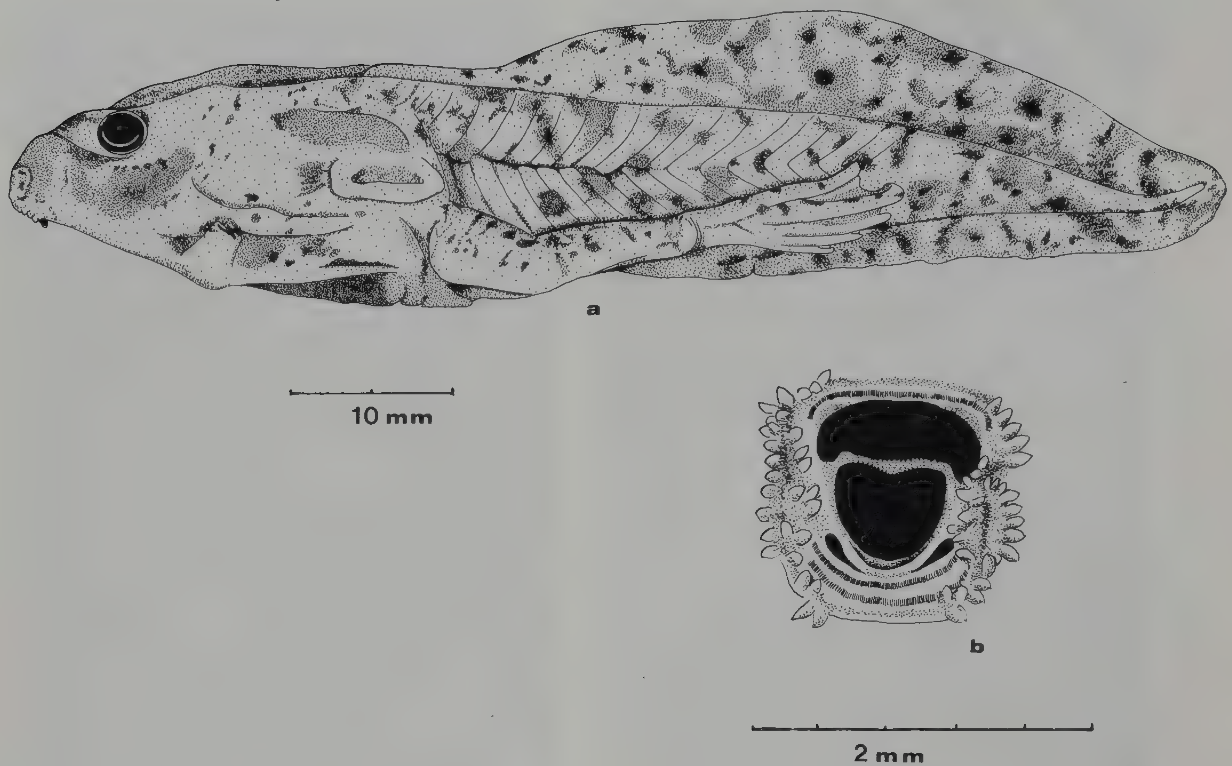



Fig. 17: Tadpole of *Euphlyctis ehrenbergii* from Ghayl Ba Wazir, GS 14.III.1962 (IZUG). a, Lateral view of tadpole. b, Larval mouth.

Tadpole: The tadpole of *Euphlyctis ehrenbergii* was first described and beautifully depicted by Anderson (1895) on the basis of one specimen from Heithalhim near Aden and "a number" of specimens from the Hadramawt Valley. The tadpoles of this Arabian frog (fig. 17) are very large, stout. The largest measures 115 mm from the snout to the tail's apex. The colouration, in preserved specimens, is greyish brown, minutely mottled dark brown on the body and with larger such speckles on the tail. The body represents about two fifths (40%) of total length, depressed. The eyes are rather large, placed on the upper surface of the head at about ⅓ the total length of the body. The distance from the eye to the snout is about equal to that from the eye to the spiracle. The nostrils are set closer to the eye than to the tip of snout, the distance to the anterior margin of the eye being nearly equal to the internarial space. The latter is smaller than the interorbital distance. The spiracle is ventro-lateral, on the left side of the body, its anterior edge being situated just behind the vertical line passing by the posterior margin of the eye. Its distance from the snout is about equal to, or slightly greater than, that to the insertion of the limbs. The opening is directed backwards and slightly upwards. The anus is directed to the right. The tail is very pointed, 1.6–1.9 times as long as the body, 4.5 times the width of its muscular part, at the base; it is about three times longer than its maximum width. The upper caudal membrane (crest) is convex and deep, about 1.5 times to twice as deep as the lower membrane. The caudal crest continues on the body, to halfway to the spiraculum and is continued anteriorly by a dorsal furrow, from which anterior extremity a fold passes to the back border of each eye. The larval mouth of these tadpoles was extensively described by Anderson (1895). The "beak" is large and strongly sclerotised, finely toothed in the middle of both jaws. The labial teeth are arranged in one dorsal and two ventral rows, the external one of the latter being slightly larger than the other. A couple of dark, corneous bands lie between the inner ventral row of labial teeth and the mandibular cornification. The papillae bordering the larval

false lips are roughly set in two series, spreading from the mouth corners toward the mesial region, both dorsally and ventrally (fig. 17b).

Biology: Although not very much is known about the population biology of *Euphlyctis ehrenbergii*, some information regarding the propagation of this frog is known from the data gathered by collectors.

Reproduction and larval development: Professor Guiseppe Scortecci collected 38 tadpoles of this frog during his trip to South Yemen in 1962, between mid-March and early June. It can be assumed that the reproduction of this species occurs in the late winter or early spring in this region, depending, of course, on rainfall and other local situations. In the sublittoral plains of the Gulf of Aden on 14.III. near the village of Ghayl Ba Wazir tadpoles were rather large (74.4–86 mm, average 80.1). The follow-

Fig. 18: Habitat of *Euphlyctis ehrenbergii* in the Wadi Sher (Hadramaut Valley), near Ghail ba Uazir (Photo: G. Scortecci).

Fig. 19: Habitat of *Euphlyctis ehrenbergii* in Wadi Masilah, near Qasem (S Yemen) (Photo: G. Scortecci).

ing day at Dek-Dik they measured from 67 to 93 mm. On 21.III. the single tadpole collected at Al Mabar was 92 mm long. With an increase of altitude there was a slow but constant decrease in the size of tadpoles starting from Al-Barh on 29.III. tadpoles measured 71–87.5 mm (mean 78.5) and Ghayl Omar (4.IV.) 61.5–67.7–79.5 mm. At Al-Ghuraf, two days later, tadpoles collected were only 52–78 mm long (average: 65) and a few of them, measuring 52–55 mm, were still legless. It was more than twenty days before tadpoles were found again, this time at Gedda (27.IV.) where they were already 76–115 mm (average 94.5) long and close to metamorphosis. In North Yemen, during his trip of 1965 Professor Scortecci was unable to find any tadpoles of this frog between July-September, although he collected many larvae of *Bufo* during this period. Drs M. Poggesi and S. Borri of the Museum of "La

Specola" in Florence, obtained several tadpoles in late September of both 1979 and 1980, but none could be found in late February and March of 1983. The results of these studies appear to rule out the possibility that *Euphlyctis ehrenbergii* may reproduce year-round as the Asian species *E. cyanophlyctis* does (Minton 1966). Near Saadah (Wadi Ar Akua), for instance, some tadpoles were ready to metamorphose on 19.IX.1979, of 40 tadpoles collected on that date 5 were legless, 33 had the hind limbs in various stages of development and 2 had four legs, with large remnants of the tail. They were caught together with many metamorphosed juveniles. At Ju Amlah, nearby, the same situation was observed on 1.IX.1980, of 49 tadpoles collected, 14 had developed very small hind limbs, 33 were found with long hind legs and 2 larvae were four-legged. Among the juveniles one maintained a short tail. Summing up the above evidence, one can assume that the reproductive activities of the Arabian frog are related to the rainfall seasons.

In the South Yemen, where peak precipitation, albeit scarce (about 20 mm), occurs from January to March, depending on localities [Walther & Lieth 1960: (2)2(1)] eggs are apparently laid in the same period, in a single deposition every year. By contrast, in the mountain parts of North Yemen rainfall comes in two separate seasons, one usually in May and another in August. As the second one is normally the most important (about 100 mm), these frogs apparently lay their eggs mostly in the late summer. They may, however, take some advantage also of the first annual rain season, as is shown by the existence of some tadpoles and very young juveniles near Ju Amlah on 15.VI.1981 and near Saadah about the same period. The time of development of these tadpoles seems to be very short, probably not exceeding 40–50 days especially when compared with their very large size (up to 115 mm). There is the possibility that some tadpoles do not reach maturity during their first rainy season and may occasionaly aestivate until the next rains, as is known to occur in *Euphlyctis cyanophlyctis*.

The mating call of males of the *Euphlyctis ehrenbergii* has not been described. The Asiatic species, though, is said to emit a prolonged "crreek-crreek", during warm, damp weather by day, as well as at night (Minton 1966).

Population structure: Of 208 specimens of *Euphlyctis ehrenbergii* collected by Professor G. Scortecci in South Yemen, 66 (31.7%) were mature females, 58 (27.9%) were breeding males with developed external vocal sacs and 84 (40.4%) were sexually immature. The body lengths (snout to urostyle) of these specimens indicate that mature males are of rather similar size (tab. 4), of about 50–60 mm (69.5%). Breeding males are somewhat larger. The variation of body lengths of most female specimens were 60–70 mm (46.9% of females). As males with body lengths of 50–60 mm are certainly mature, it follows that most, or possibly all, immature specimens of this size are probably females. The size structure of females, therefore, may not be very different from that of males, both averaging 50–60 mm. The difference being that about half of the females of this size are immature. As body lengths (snout to vent) of tadpoles ready to metamorphose range from 28 to 41 mm, in as much as immature specimens of newly metamorphosed juveniles 11.5–40 mm are easily accounted for, it follows that males are probably ready to mate after their first season of life, while most females apparently need one more year to achieve gonadal maturity. It seems that the life span of adults in males is not much longer than their first breeding season, while some females probably survive two breeding seasons. The largest individuals measuring 100 mm or more are likely to be at least four or five years old.

Nutrition: *Euphlyctis ehrenbergii* seems to prey on aquatic or semiaquatic organisms, only. Many specimens of both sexes showed by disection, to have fed on larval instars of Odonata (undertermined), but also on small fish (*Aphanius dispar* Rüppell, 1828). In one case, a female from Madinat al Abid, the mouth and guts were stuffed with eggs of *Bufo.* It is rather likely that this species may feed also on tadpoles or small adults of other amphibians. Several specimens of both sexes from South Yemen, and particularly from Al Barak, proved by disection to have eaten large quantities of filamentous green algae.

Fig. 20: Habitat of *Euphlyctis ehrenbergii* in the Oasis of Madi (S Yemen). (Photo: G. Scortecci).

The meaning of this latter finding is, however, obscure. None of the specimens examined seemed to have fed on terrestial insects. "*Euphlyctis cyanophlyctis* may feed also on flies" (Minton 1966). Field observations of this large frog indicate that it is in fact an aquatic feeder though also taking wasps, dragon flies and other insects that hover over the water or perch on grasses or rocks nearby. However, it is not found away from water, only on rocks protruding out of the water, where they are fond of basking in the sun for long periods.

Systematics: Although Boulenger (1882a: 17–18) first considered *Rana ehrenbergii* Peters specifically distinct from *Rana cyanophlyctis* Schneider, he later changed his view (Boulenger 1882a: 110), and synonymized it with the latter. This same opinion was held by various authors (see the synonymic list above), until Parker (1941) treated the taxon as a subspecies. The characters originallly considered to distinguish the two species were mainly the size of tympanum (two thirds of the diameter of the eye, in *Euphlyctis cyanophlyctis* and half of it in *Euphlyctis ehrenbergii*) and the body length which is greater in the latter. A further, additional character, would have been represented by a somewhat more verrucose back in the Indian species.

The Arabian frogs differ from their south Asian related species by having a tympanum of a smaller size and comparatively more removed from the eye and being of a much larger size. The distance from eye to tympanum is about half of the diameter of the latter organ, in *E. ehrenbergii* and 20–30% of it in *E. cyanophlyctis* (tab. 1). The difference proved highly significant ($p = 0.001$) when tested with a covariancy analysis. The biological meaning of different sizes is more difficult to interpret. Considerable size differences are found not only between species, but among different populations as well. In *Euphlyctis cyanophlyctis*, for instance, Dubois (1974) reported that females from central Nepal (32 populations checked) do not exceed 55 mm in body length, while one specimen from eastern Nepal measured 57 mm from snout to vent (2 populations checked). Among the material of this species that we studied for comparison with those from Arabia, the body length reaches 59.2 mm in one female from Scully (Nepal), 68.1 in one from Kelarh (Sri Lanka), 62.7 in one from Baluchistan, 64.4 in another from Kashmir and 70.0 mm in one from Afghanistan. In *Euphlyctis ehrenbergii* mature females from populations sampled from South Yemen normally (47% of cases) measure 50–60 mm, but 29% of them are only 50–60 mm in their body length, thus providing a rather wide margin of overlapping sizes with the other species. A lesser number (4.5% of total) reaches 80 mm or more. Populations from North Yemen, in contrast, have females that are much larger, in some cases reaching sizes of 100 mm or more. Summing up this evidence, it appears that the Arabian populations may be more easily distinguished from those from southwest Asia on the position of their tympanum and its relative dimensions, as already stated above, rather than on size alone.

From the standpoint of evolutionary biology there is scarcely a doubt that no gene flow is possible between the two species. The biometrical differences existing between the two species may certainly allow recognition of a specimen from one population from that of another. *Euphlyctis cyanophlyctis* was reported from Iran by Mertens (1956) and Anderson (1963). Insofar as we were able to ascertain, it has never been collected in Iraq or Syria (Reed & Marx 1959, Werner 1939). Although the herpetofauna of these regions are rather scantily known generally, it is unlikely that such a conspicuous species may have been unnoticed.

Ecology and ethology: *Euphlyctis ehrenbergii* like the south Asiatic *Euphlyctis cyanophlyctis*, is a frog of mostly aquatic habits and what was noted of its diet in adults confirms that it seldom leaves water, even for trophic reasons. Field notes taken by collectors seem to confirm that this species is linked to habitats with perennial or semiperennial waters. The Asiatic species, *Euphlyctis cyanophlyctis* is normally found in anthropophilous situations, as in rice fields, or in swamps (Minton 1966, etc.).

A rather peculiar ethological character shown by both species, and shared by *Euphlyctis tigerina*

(GÜNTHER 1864: 407) and possibly also by *Euphlyctis hexadactyla* (DUBOIS 1974: 378), is that these frogs are able to skitter over the surface of water. ANDERSON (1895: 661–662) was the first author to report this peculiarity of the Arabian *Euphlyctis ehrenbergii.* A letter written by Sir William Flower's son and another from Col. J. W. Yerbury noted that when they are frightened, these frogs jump from the banks or rocks and may take a dozen leaps before finally plunging into the water, or may even reach the opposite side of the water. They may also "jump out of the water in the middle of a pond, and leap along the surface in a wonderful manner, finally jumping out on the land" (Flower in litt., as quoted by ANDERSON 1895). This habit might not be shared by the largest specimens (Col. Yerbury, ibid.). Hence, the Asiatic species is called the "skittering frog", which name may well be applied to *Euphlyctis ehrenbergii.*

*Euphlyctis ehrenbergii* is found at almost any elevation from near 23°N southwards through Yemen then eastward to the Hadramawt. They are most common in pools of perennial water. However, they have been observed in great numbers in ponding areas and basins that only contain water after unusually heavy rains and flooding. This indicates an ability to sustain aestivation for long periods after the pond is dry, as it may be a year or two or more before there is sufficient rainfall to replenish this intermittent habitat. *Euphlyctis ehrenbergii* is most common westward and southward of the hydrological divide of the narrow montane periphery of the southwestern part of the peninsula. On the seaward side of the divide the intermittent pools in the wadi bottoms that incise the constricted coastal littoral are quite abundant and fed by ground waters being nearly permanent. On the inland side of the divide, for the most part the run off rather quickly debouches into great sand areas and the more desertic drier climatic conditions prevail.

*Euphlyctis ehrenbergii* was collected in the vicinity of Riyadh 14.III.1984 by I. Sheila Collenette, an astute observer of natural history. As her collecting site was in the vicinity of the King Saud University, it may be that these frogs were purchased by the university as study specimens and either were released or escaped to present this dilemma of their distribution. The only amphibian heretofore known from the vicinity of Riyadh was *Bufo dhufarensis* collected in 1972 (JG & John Burchard). Its occurrence, too in this vicinity was probably recent. This is best substantiated by the fact that H.St.J.B. Philby, and inveterate natural history collector lived in Arabia for 40 years, many of those years in Riyadh. His collections include frogs and toads from many widespread places in Arabia, but not Riyadh. The report of *Rana cyanophlyctis ehrenbergii* Peters, "Four adults, Hofuf, E. Arabia" HAAS & BATTERSBY (1959: 198) is here dismissed as an error. The deep well pump, the increase of agricultural activities and the superb highway systems will undoubtedly create many more such artificial populations of herpetofauna in Arabia in the future, including amphibians.

## ZOOGEOGRAPHICAL CONCLUSIONS

Of the Amphibia only nine species of Anura are known to occur in the Arabian Peninsula. All of them are of considerable zoogeographic interest and can be usefully employed to outline the origin and evolution of the Arabian fauna (see also BÜTTIKER 1979, KRUPP 1983, LARSEN 1984, etc.).

The first thing to be considered is that six of these species are endemic to the peninsula. The fact that related species range either in the Ethiopian Region or in the Indian Region clearly demonstrates that the Anuran fauna of the peninsula is mostly of south-tethyian origin and that Arabia was once a land bridge for the faunistic migrations which characterised the interchange of elements between Asia and Africa (see BALLETTO 1968 for a detailed analysis of the zoogeographical relationships with the Horn of Africa). Regarding Indo-Ethiopian elements among the amphibians in Arabia, the species which best outlines this pattern is *Bufo dhufarensis,* an Arabian endemic, closely related to the Indian *Bufo stomaticus* and, at least morphologically, to *Bufo dodsoni,* from Somalia. Apart from the colour of the vocal

Fig. 21: A breeding site of *Bufo dhufarensis* in the mountains of the Hadramaut Valley (Photo: G. Scortecci).

sacs of males, no morphological feature can be used by itself as a sure differentiation of the two species. *Bufo dodsoni* is closer related, by skeletal features, to *Bufo arabicus,* another Arabian endemic. *Bufo dodsoni* is also allied, by its cranial characters, to *Bufo scortecci*, an endemic of Yemen, whose external morphology is somewhat intermediate between *Bufo arabicus* and *Bufo dhufarensis*, being closer to the former, morphologically, and to the latter by characteristics of its tadpole. *Bufo hadramautinus,* from the vicinity of Mukalla, is another restriced enemic, probably derived from a *Bufo orientalis*-like ancestor in more recent times.

**Table 5: List of sympatric occurence of Arabian Anura.**

| | | | *Bufo tihamicus* | *Bufo dhufarensis* | *Bufo viridis* | *Bufo arabicus* | *Bufo hadramautinus* | *Bufo scortecci* | *Hyla savignyi* | *Rana ridibunda* | *Euphlyctis ehrenbergii* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lahij | 13°04'N 44°53'E | 150 m | • | • | | • | | | | | • |
| Haithalhim | 13°06'N 44°53'E | 200 m | • | • | | • | | | | | • |
| Hakimah | 17°01'N 42°50'E | 80 m | • | • | | • | | | | | • |
| Al Lith | 20°09'N 40°17'E | NSL | • | | | • | | | | | • |
| Sukhnah | 14°48'N 43°26'E | 350 m | • | • | | | | | | | • |
| Khasawiyah | 16°56'N 42°37'E | 25 m | • | • | | | | | | | |
| Al Bazra | 14°51'N 42°59'E | NSL | • | • | | | | | | | |
| Bir Hebn el Uan | 13°18'N 43°20'E | 75 m | • | • | | | | | | | |
| Abyan | 13°10'N 45°20'E | 50 m | • | | | | | | | | • |
| Wadi Mahra | 19°38'N 41°54'E | 1900 m | | • | | • | | | • | | |
| nr Al Alayyah | 19°37'N 41°59'E | 2200 m | | • | | • | | | • | | |
| Makkah | 21°27'N 39°49'E | 270 m | | • | | • | | | | | |
| Makkah by-pass km 126.5 | 21°19'N 40°00'E | 300 m | | • | | • | | | | | |
| Wadi Buwwah | 20°46'N 41°12'E | 1400 m | | • | | • | | | | | |
| Sheikh Othman | 12°42'N 44°59'E | NSL | | • | | • | | | | | |
| Masafi | 25°18'N 56°10'E | 400 m | | • | | • | | | | | |
| Jammah | 23°33'N 57°31'E | 200 m | | • | | • | | | | | |
| Wadi Rostaq | 23°23'N 57°27'E | 270 m | | • | | • | | | | | |
| Wadi Sahtan | 23°22'N 57°19'E | 760 m | | • | | • | | | | | |
| Muscat | 23°37'N 58°35'E | NSL | | • | | • | | | | | |
| Wadi Kebir | 23°26'N 58°34'E | 60 m | | • | | • | | | | | |
| Wadi Qid | 23°12'N 58°37'E | 760 m | | • | | • | | | | | |
| Ingrams | 14°36'N 49°01'E | 760 m | | • | | | • | | | | |
| Riyadh | 24°38'N 46°43'E | 620 m | | • | | | | | | | • |
| Wadi Hiswah | 18°02'N 42°19'E | 800 m | | • | | | | | | | • |
| Wadi Maraba | 17°54'N 42°23'E | 450 m | | • | | | | | | | • |
| Hebis | 14°38'N 49°09'E | 150 m | | • | | | | | | | • |
| Mukallah | 14°32'N 49°08'E | NSL | | • | | | | | | | • |
| Taif | (?)21°16'N 40°24'E | 1600 m | | | • | • | | | | | |
| Bani Mashoor | 19°00'N 42°09'E | 2300 m | | | • | • | | | • | | |
| vic. Abha | 18°13'N 42°30'E | 2000 m | | | • | • | | | • | • | |
| vic. Sawdah | 18°16'N 42°24'E | 2500 m | | | • | • | | | • | • | |
| An Nimas | 19°07'N 42°08'E | 2250 m | | | • | • | | | • | • | |
| Al Khadra | 19°19'N 42°05'E | 2800 m | | | • | | | | • | | |
| Wadi al Qaarah (Jeman) | 18°02'N 42°42'E | 2100 m | | | | • | | | • | • | • |
| vic. Hijla | 18°18'N 42°38'E | 1900 m | | | | • | | | • | • | |
| Dana Shalal | 18°55'N 42°12'E | 2300 m | | | | • | | | • | • | |
| Wadi Thereira | 21°09'N 40°44'E | 1600 m | | | | • | | | • | | • |
| Wadi Shumruq | 20°29'N 41°20'E | 1600 m | | | | • | | | • | | • |
| vic. Sana | 15°21'N 44°12'E | 2400 m | | | | • | | | • | | • |
| vic. Mabar | 14°48'N 44°17'E | 2400 m | | | | • | | | • | | • |
| Bani Sar | 20°05'N 41°26'E | 2000 m | | | | • | | | • | | |
| vic. Wadi Wajj | 21°08'N 40°14'E | 2000 m | | | | • | | | • | | |
| Amran | 15°38'N 43°50'E | 2300 m | | | | • | | | • | | |
| vic. Saadah | 17°10'N 43°33'E | 1950 m | | | | • | | | | | • |
| Jebel al Khattarin | 16°44'N 43°54'E | 1980 m | | | | • | | | | | • |

**Table 5, continued**

| | | | *Bufo tihamicus* | *Bufo dhufarensis* | *Bufo viridis* | *Bufo arabicus* | *Bufo hadramautinus* | *Bufo scortecci* | *Hyla savignyi* | *Rana ridibunda* | *Euphlyctis ehrenbergii* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Medinat al Abid | 14°39′N 43°57′E | 1300 m | | | | • | | | | | • |
| Hammam Ali | 14°36′N 44°09′E | 1600 m | | | | • | | | | | • |
| Rasyan | 13°38′N 43°46′E | 350 m | | | | • | | | | | • |
| vic. Taizz | 13°34′N 44°02′E | 1370 m | | | | • | | | | | • |
| Azraki Ravine | 13°22′N 44°39′E | 550 m | | | | • | | | | | • |
| Wadi al Khalili nr Mafhaq | 15°07′N 53°54′E | 1550 m | | | | • | | • | | | |
| Wadi Shumruq | 20°29′N 41°20′E | 1600 m | | | | | | | • | | • |

The Indian Anuran fauna is represented in Arabia by *Euphlyctis ehrenbergii,* closely allied to *Euphlyctis cyanophlyctis*, distributed from Iran to Malay. The genus *Euphlyctis* is certainly an element of the Indian Region, but is apparently also close to the Ethiopian *Conraua.* Both genera are comprised of large to very large frogs, with a stout habit and a strongly aquatic character, all primarily of forested areas. *Euphlyctis ehrenbergii* is the largest and stoutest of its genus and probides a link, in this feature as well as in some osteological features, to the African *Conraua* as well as having ecological and biological affinities to the Indo-asiatic *Euphlyctis cyanophlyctis.*

The element that reached the peninsula in most recent times are certainly the Palearctic species, represented, among the Amphibians, by the Euro-Turanic *Bufo viridis, Rana ridibunda* and *Hyla savignyi.* The species, especially *Rana ridibunda,* are probably best regarded as species-complexes as they may well prove to constitute groups of cryptic, phylogenetically related biospecies. *Hyla savignyi*, distributed from Lebanon to Iran and in Arabia is closely allied to the European complex of *Hyla (H. arborea, H. sarda, H. meridionalis).* As in the case of some of the other faunal forms noted above, its arrival in Arabia coincided wiht a time of more abundant rainfalls and milder climate perhaps during the Würm glaciation or during the late pluvials.

*Bufo tihamicus* undoubtedly derived from the same stock as the African *Bufo pentoni.* Their separation occurred since the southwards advance of the Sahara Desert and before the opening of the Red Sea, 2–5 million years before present.

## CONSERVATION

This paper demonstrates that very little is known about the Amphibian fauna of Arabia. Therefore, studies on distribution, status, biology and ecology of amphibians should be promoted to broaden local knowledge and to provide the necessary guidelines for conservation and management of these species and their habitats.

Inventories of important amphibian habitats should be established on a regional and national basis. Measures for their conservation should be promoted through public information, education and when necessary legislation and law enforcement for habitat protection.

As the Anura are prolific in their reproductive activities, their spawn is of great food value for fish and many other animals, their larvae and the adults are an important source of food for many species of birds, mammals and reptiles. Therefore, indiscriminate poisoning of streams, ponds and water cours-

es to kill mosquitos and other pests may not only exterminate the intended victims (mosquitos, etc.) but will certainly exterminate or at least effect severely the toads, frogs and fish.

Poisoning and other pollution of streams, ponds and other waters e.g. through careless use of fertiliser insecticides and herbicides in agricultural areas should be prevented. Use of chemical pest control in, or near amphibian habitats should only be considered in extreme cases under competent supervision, after ecological studies have determined that this would not be counterproductive.

## ACKNOWLEDGEMENTS

With the greatest pleasure we thank many friends, colleagues and institutions for their assistance.

First, Prof. W. Büttiker, who invited us to prepare this paper, collected many specimens for study and patiently endured considerable delay in receipt of the manuscript. He provided the excellent habitat photographs. Our most sincere thanks are extended to Ms. A. G. C. Grandison, Dr. E. N. Arnold and B. T. Clarke, British Museum (N. H.), Dr. L. Capocaccia and V. Raineri (Museo Civico di Storia naturale, Genova), J. L. Perret (Museum d'Histoire naturelle, Genève), Prof. B. Lanza, Dr. M. Poggesi and Dr. M. Borri (Museo Zoologico de la Specola, Universita di Firenze), Dr. J. Eiselt (Naturhistorisches Museum, Wien), Dr. F. Klemmer (Senckenberg Museum, Frankfurt a. M.), who allowed us to study the abundant material in their collections, including many type specimens, and provided us with much of the literature. With great appreciation we thank Dr. R. C. Drewes, Chairman of the Department of Herpetology of the California Academy of Sciences, who read the manuscript and offered much constructive criticism. We are grateful to Elinor De Angelis, who skillfully prepared the distribution maps, and to Patricia Orton of AMARTECH who painstakingly typed the final draft.

In addition to those people, who years ago, sent zoological specimens to various institutions, in the past few years we have received more material from many people. Without their contribution this work would not have been possible. To all of them, past and present, we owe a special debt of gratitude. In the text, they are indicated by their initials (see list of abbreviations).

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# Notes on Breeding the Arabian Wolf (*Canis lupus arabs*) in Captivity

**C.W. Furley**

Abstract: The breeding cycle of the Arabian Wolf (*Canis lupus arabs* Pocock, 1934) in captivity at Al Ain Zoo and Aquarium was studied. The approximate dates of birth for ten litters indicated that whelping in this subspecies occurs chiefly during February and March. This compliments observations on the seasonal breeding in other subspecies of wolf in captivity and in the wild.

Keywords: *Canis lupus arabs*, breeding cycle, Al Ain Zoo.

ملاحظات حول تكاثر الذئب العربي Canis lupus arabs في الأسر

ك • و • فيرلي

خلاصة : تمت دراسة دورة تكاثر الذئب العربي Canis lupus arabs المأسور في حديقة حيوانات العين • وتشير تواريخ الميلاد التقريبية لعشرة جراء على ان توالد تحت النوع هذا يحصل خلال شهري شباط وآذار • وتكمل هذه الدراسة مشاهدات أخرى حول التكاثر الموسمي لتحت انواع اخرى من الذئاب في الأسر وفي الطبيعة •

## INTRODUCTION

No records of timing of breeding for the Arabian Wolf have so far been published. In view of the rarity of this subspecies, both in the wild and in captivity, this study was made to record information on the seasonality of breeding in captivity at its natural latitude, and to discuss possible factors influencing this phenomenon. Photoperiodism, the mechanism by which a wide variety of animals are stimulated to breed at certain times of the year by the change in daylight length, has been well documented in ungulates and other mammals (Ansell 1960, Dasman & Mossman 1962, Fairall 1968, Spinage 1973, Skinner et al. 1974, Leuthold & Leuthold 1975). Wild canids appear also to be affected by changes in daylight length, although literature on this subject is sparse. The possible role of photoperiodism, and management factors, affecting the results obtained in this study, is discussed.

## METHODS

The wolf pen in Al Ain Zoo and Aquarium, a bare area of ground measuring approximately 50 m × 50 m containing a few dead trees, was checked daily by zoo staff in the morning and afternoon as part of the zoo routine since the first wolves arrived. The original number of wolves introduced into the pen in the early 1970's was not recorded, but in December 1978, 28 animals were counted. The total number of wolves was counted at the end of each year thereafter. The total wolf count did not

differentiate between the sexes or age groups. The dates on which pups were seen above ground for the first time were noted for the years 1977–1983 inclusive. These data were then examined for evidence of seasonal breeding.

## RESULTS

The results for each year are considered separately. – 1977: a litter of four pups was first seen on March 24th. The pups appeared to be approximately 3-5 weeks old, and in good health. No record was taken in December of the total wolf count. – 1978: a litter of three was seen first on February 7th, and a second litter was seen first on February 17th. The total wolf count in December was twenty-eight. – 1979: no litters were recorded this year. The December wolf count was twenty-two. – 1980: no litters were recorded this year. The December wolf count was seventeen. – 1981: two, possibly three litters were seen simultaneously on March 17th, totalling ten pups. No individuals from any of the litters had emerged before this date. Notes taken at the time indicate that the ambient temperature had suddenly risen from below 31 °C to 31 °C. Some of these pups were in poor bodily condition, and were killed by cage-mates a few days later. Once above ground, they could be seen every day at dusk with the adults. The December count was twenty-two. – 1982: a litter was seen on February 6th, possibly two litters, totalling six pups. Another litter was seen on February 22nd. Both these groups appeared to be approximately two to three weeks old. The second litter spent much of the following time underground again as the daytime temperature had dropped to 19 °C. The total wolf count in December was 41, but no new litters were recorded during the summer or autumn.– 1983: a dead pup approximately ten days old was removed on February 28th. Three separate litters, of three pups each, were seen on March 20th, 22nd, and 29th. There were distinct differences in the size of these pups, indicating some had stayed in the burrow longer than others. The total wolf count in December was twelve, however, the drastic reduction in numbers being due to flooding of the wolf pen during May, which drowned many animals in their burrows.

## DISCUSSION

The Arabian Wolf burrows underground for shelter and safety, and the captive group at Al Ain Zoo have dug an extensive system of underground burrows in the soil of the wolf pen. The pups are born in these burrows, so the actual date of birth cannot be obtained. However, all litters apparently left the burrows for the first time during daylight between the ages of two and five weeks, and birth dates may therefore be estimated retrospectively.

Our results indicate that this group of wolves produced offspring in January, February and March. The litters seen on February 7th 1978 and February 6th 1982 must have been born in January of those years. External factors governing the timing of breeding in mammals are known to include latitude, rainfall, nutritional status, and social environment (Fairall 1968, Leuthold & Leuthold 1975). Of these factors, the captive wolves in Al Ain experience a constant nutritional status which is not influenced by seasonal availability of prey. However, the social environment changed from year to year, but the exact ages and the sexes of individual wolves were not recorded. Latitude (hence change in daylight length) may play a role in influencing the breeding of these wolves. It is worth noting that Al Ain Zoo lies within the borders of the natural distribution of this subspcecies in the Arabian peninsula (Harrison 1968), thus eliminating differences due to unnatural geographical location.

Fig. 1: The Arabian Wolf *(Canis lupus arabs)*; this photograph shows a lactating female during March 1984. The development of the mammary glands is often the only initial indication that there may be pups underground.

In 1977 and 1978 at least one adult female must have been present in the group to have produced the two litters recorded in those years. However, it is not known whether any litters were in fact produced in 1979 and 1980, as they may have been born underground and eaten or died of natural causes without ever having been seen by staff. However, the wolf counts between 1978 and 1979 decreased by six, so perhaps these included breeding females. Similarly the wolf count between 1979 and 1980 decreased by five. Breeding females must have been present in 1981 to produce three litters, but it is not known if they were the same individuals who produced the litters in 1982 and 1983. The large wolf count in December 1982 included some individuals previously unaccounted for, as a total of twenty-two wolves seen in December 1981, in addition to the recorded number of pups, could not produce such a figure. The discrepancy may be due to a much larger number of pups being born in the spring than was noted.

Records of wild Asiatic canids in other zoological collections indicate breeding is also seasonal in these. Morris & Jarvis (1962) record spring births at Regent's Park Zoo, London, for the Tibetan Wolf *(Canis lupus chanco)*, the Indian Wolf *(Canis lupus pallipes)*, and the Asiatic Jackal *(Canis aureus)*. The Indian Wolf gives birth in Jaipur Zoo from November to January (Yadav 1968), and in Regent's Park Zoo, London, another record shows births from March to May (Zuckerman 1953). The Asiatic Jackal gives birth in captivity in spring in San Francisco, U.S.A. (Reuther & Doherty 1968), and also in Bucharest Zoo (Cociu & Cociu 1976). The European Wolf in Bucharest Zoo gives birth in spring and early summer. The seasonal breeding of the Arabian Wolf in captivity in Al Ain, United Arab Emirates, does not contradict the pattern exhibited by other wild canid species from the Middle East held in captivity. These animals may react to changes in daylight length, and it is possible this is a strong influence in view of the consistent births in the early months of the year.

## ACKNOWLEDGEMENTS

I would like to thank the curators of Al Ain Zoo and Aquarium for giving me access to the earlier records of the zoo for preparation of this paper.

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# The Carnivora of Arabia

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Abstract: Previously unreported and recent records of the Carnivores from Arabia are listed, supplemented by distribution maps. All previous records are referred to. A review of the taxonomic status and synonymy is presented. Numerous references to Carnivora of Arabia are given. Aspects of the ecology and species status are discussed and measures for the protection of carnivores are recommended. Proposals for the re-introduction or redistribution of some species into protected areas are made. Also measures for predator control (in the case of the common fox and feral cat) are suggested.

Keywords: Arabia, carnivores, check-list, taxonomy, synonymy, distribution, ecology, conservation.

آكلة اللحوم في الجزيرة العربية

ج • جسبرتي ، د• ل • هاريسون و و• بوتيكر

خلاصة : يحتوي المقال على معلومات تتعلق بوجود انواع لم تعرف أو تذكر سابقا من العربية السعودية ، وخرائط تبين مدى انتشارها ، هذا بالاضافة الى تعداد كل ما كان معلوما عن الموضوع سابقا • كما انه يعرض ملحقا للمراجع التي تذكر آكلة اللحوم في شبه الجزيرة العربية • ويلحظ المقال النواحي البيئية والواقع التصنيفي لهذه الحيوانات ، ويوصى بأتباع بعض الطرق للحفاظ عليها ، وأخيرا يقترح الباحثون اعادة استقدام وتوزيع بعض الانواع في مناطق محمية من البلاد •

## CONTENTS



## 1. INTRODUCTION

Any discussion of the mammals of Arabia refers to the bench mark work, HARRISON'S "Mammals of Arabia" (3 Volumes 1964, 1968 & 1972) wherein was summarized and tabulated the knowledge of the mammalian fauna of the peninsula including Iraq, Syria, Lebanon, Sinai, Palestine and Jordan. The Carnivora were treated in Volume 2 (1968).

Since that time almost twenty authors have contributed to the knowledge of the carnivora of the peninsula in about as many books, notes and papers. These are all cited in the text, in the section "Previously reported" appended to each species, some in Appendix 6.2 "Taxonomic Tables" and of course all of them are listed in References, which is, in fact, a bibliography of the Carnivora of the Arabian Peninsula.

In this work the order of Carnivora is exhaustively reviewed. Fifteen species are discussed. Of these, one species, the cheetah, *Acinonyx jubatus,* is probably extinct at this writing. Another species, *Pathera pardus,* the leopard is in dire straits, suggesting the necessity of immediate protection from further wanton destruction of this noble feline.

For each species the synonymy is reviewed, followed by a brief description of the animal, its food requirements and habits and habitat. The general distribution and its distribution in Arabia and distribution map for each species known to exist is presented. The extralimital distribution as shown is from Harrison (1968) for Iraq, Syria, Lebanon and Jordan. Southeast Asian and East African locations are taken graphically from Harrison's (1968) distribution maps. Occurrences in Iran are taken from Lay (1967) and distribution in Egypt and Sinai is from Osborn & Helmy (1980).

The distribution maps reflect the historic distribution of the species and their geographical province rather than status, many species being now extinct in much of their previous range.

In the "Records and Map Designations" sections are listed all previous records with map designations and references to the literature. Also listed are previously unreported records including dates and places with geographical coordinates. The collectors or observers are noted by initials.

A table of the initials employed in the reportage and the contributors names is given in the Appendix 6.1 of abbreviations, and the taxonomic tables in Appendix 6.2 include all available measurements of the Arabian Carnivora. Taxonomic data of 169 specimens were gleaned from the literature (most from Harrison, 1968); in this work measurements of 41 specimens have been added, or almost 20% of the total to date.

## 2. CHECK-LIST

Presently twelve (12) genera of five (5) families represented by 15 species have been recorded in Arabia.

Order **Carnivora.** Carnivores

Fam. **Canidae.** Dogs, Jackal, Wolves, and Foxes

Genus ***Canis*** Linnaeus, 1758

*Canis aureus aureus* Linnaeus, 1758. Jackal
*Canis aureus syriacus* Hemprich & Ehrenberg, 1833
*Canis lupus arabs* Pocock, 1934. Wolf
*Canis lupus pallipes* Sykes, 1831

Genus ***Vulpes*** Oken, 1816. Foxes

*Vulpes vulpes arabica* Thomas, 1902. Fox
*Vulpes rueppelli sabaea* Pocock, 1934. Rüppell's Sand Fox

Genus ***Fennecus*** Desmarest, 1804
*Fennecus zerda* (Zimmerman, 1780). Fennec

Fam. **Mustelidae.** Weasels, Polecats, Martens, Badgers, and Otters

Genus ***Mellivora*** Storr, 1780
*Mellivora capensis wilsoni* Cheesman, 1920. Ratel or Honey Badger
*Mellivora capensis pumilio* Pocock, 1946

Fam. **Viverridae.** Genets and Mongooses

Genus ***Herpestes*** Illiger, 1811
*Herpestes edwardsi ferrugineus* Blanford, 1874. Indian Grey Mongoose

Genus ***Ichneumia*** Geoffroy, 1837
*Ichneumia albicauda albicauda* (G. Cuvier, 1829). White-tailed Mongoose

Genus ***Genetta*** Oken, 1816
*Genetta felina granti* Thomas, 1902. Genet

Fam. **Hyaenidae.** Hyaenas

Genus ***Hyaena*** Brisson, 1762
*Hyaena hyaena syriaca* Matschie, 1900. Striped Hyaena
*Hyaena hyaena sultana* Pocock, 1934

Fam. **Felidae.** Cats

Genus ***Felis*** Linnaeus, 1758
*Felis silvestris tristrami* Pocock, 1944. Wild Cat
*Felis silvestris iraki* Cheesman, 1921
*Felis silvestris gordoni* Harrison, 1968
*Felis margarita harrisoni* Hemmer, Grubb & Groves, 1976. Sand Cat

Genus ***Caracal*** Gray, 1843
*Caracal caracal schmitzi* (Matschie, 1912). Caracal

Genus ***Panthera*** Oken, 1816
*Panthera pardus nimr* (Hemprich & Ehrenberg, 1833). Leopard
*Panthera pardus tulliana* (Valenciennes, 1856)

Genus ***Acinonyx*** Brookes, 1828
*Acinonyx jubatus venaticus* (Griffith, 1821). Cheetah

# 3. SYSTEMATIC LIST

## Fam. **Canidae**

### Genus ***Canis*** Linnaeus, 1758

The genus is typified by a relatively short tail, equalling less than ⅔ the length of the head and body, rather long legs and heavy skull. Relatively coarse, short pelage. Ancestral to the dog.

Dentition: i $\frac{3}{3}$ c $\frac{1}{1}$ pm $\frac{4}{4}$ m $\frac{2}{3}$ = 42

***Canis aureus aureus*** Linnaeus, 1758. **Jackal**

1758 *Canis aureus* Linnaeus: Syst. Nat. 10th Ed. *1:* 40, Lar, Persia (Iran).
1896 *Canis hadramauticus* Noack; Noack, Zool. Anz.: 356, Aden.
1926 *Canis aureus riparius* Hemprich & Ehrenberg; Schwarz, Senck. *8 (1):* 39 p. 43, Aden.
1938 *Canis aureus aureus* Linnaeus; Pocock, Proc. Zool. Soc. *108 B:* 38, Central and South Arabia.

***Canis aureus syriacus*** Hemprich & Ehrenberg, 1833

1833 *Canis syriacus* Hemprich & Ehrenberg: Symb. Phys. Mamm. 2, sig. Z, pl. 16, "between Beirut and Tripoli" (Lebanon).
1938 *Canis aureus syriacus* Hemprich & Ehrenberg; Pocock, Proc. Zool. Soc. *108 B:* 38.

*C. a. syriacus* has not been authentically recorded as an Arabian race although it may possibly be found to exist in the northern reaches of the peninsula.

The jackal can be confused with a young wolf (TL 82–102 cm, T 21–27 cm) and stands 40–50 cm high. As Hatt (1959 p. 37) points out "the colour range of jackals is considerable even in one area". The races found in Arabia, *C. a. aureus* and, further north *C. a. syriacus* are distinguished by colouring, the former being dark and the latter being of a light brown sandy colour. Harrison (1981 p. 49) says "Its hair is shaggy and its colour variable: generally brown with black speckling on its back, and white ventrally. The Asiatic jackal does not have a defined black spinal mane and the tail is strongly variegated in black, white and tan brown."

Their food requirement of about ½ kg per day can be extremely varied. Basically carnivorous scavengers of nocturnal habit, they are also crepuscular and in cooler weather may roam diurnally. They often forage for carrion in groups of 12 animals or less, more often in pairs. In addition to carrion they eat birds, small mammals, reptiles, amphibians and large insects. They are fond of vegetables, watermelons, tomatoes, pumpkins, corn as well as fruits and berries.

*Canis aureus* is distributed in southeast Europe from Hungary and Rumania eastwards through Lebanon, Palestine, Jordan, Syria, Iraq and Iran to southern Russia, Samarkand and Bokhara, the Indian subcontinent including Sri Lanka and easterly to Nepal, Assam, Burma and Thailand. In north Africa it ranges from Senegal, Rio de Oro and Morocco to Egypt and south to Kenya.

In Arabia the jackal is a rare animal, confined to the oases of Al Qatif and Al Hofuf and the vicinity of Aden. A recent sight record near Al Jawf in the southern reaches of the Wadi Sirhan complex, however, opens a new vista of the likely distribution of this animal.

In much of its range the jackal has been exterminated with poison baits because of the fear of the spread of rabies.

It is almost certain that at this writing the jackal as a species in Arabia is extremely endangered. Urgent measures should be adopted to safeguard its survival. It should be protected in the few areas from where it is known, e. g. through the establishment of sanctuaries or by introducing specific protective measures such as banning of poison as well as an extensive education campaign. Captive breeding for later reintroduction to protected areas might also be investigated.

Records and map designations (fig. 1, table 1):

Previously reported: 1., 2. YERBURY & THOMAS, 1895 p. 548; 3. CHEESMAN, 1926 p. 53; a) SCHWARZ, 1926 p. 46; b) CHEESMAN & HINTON, 1926 p. 355.

In this work: 4 – 1946 nr Safwa 26°39′N 49°58′E, photograph (HZM archives) of jackal killed, mistaken for a wolf, JG; 5 – 1977 in desert nr Hofuf 25°24′N 49°29′E and Jabal Qarah 25°27′N

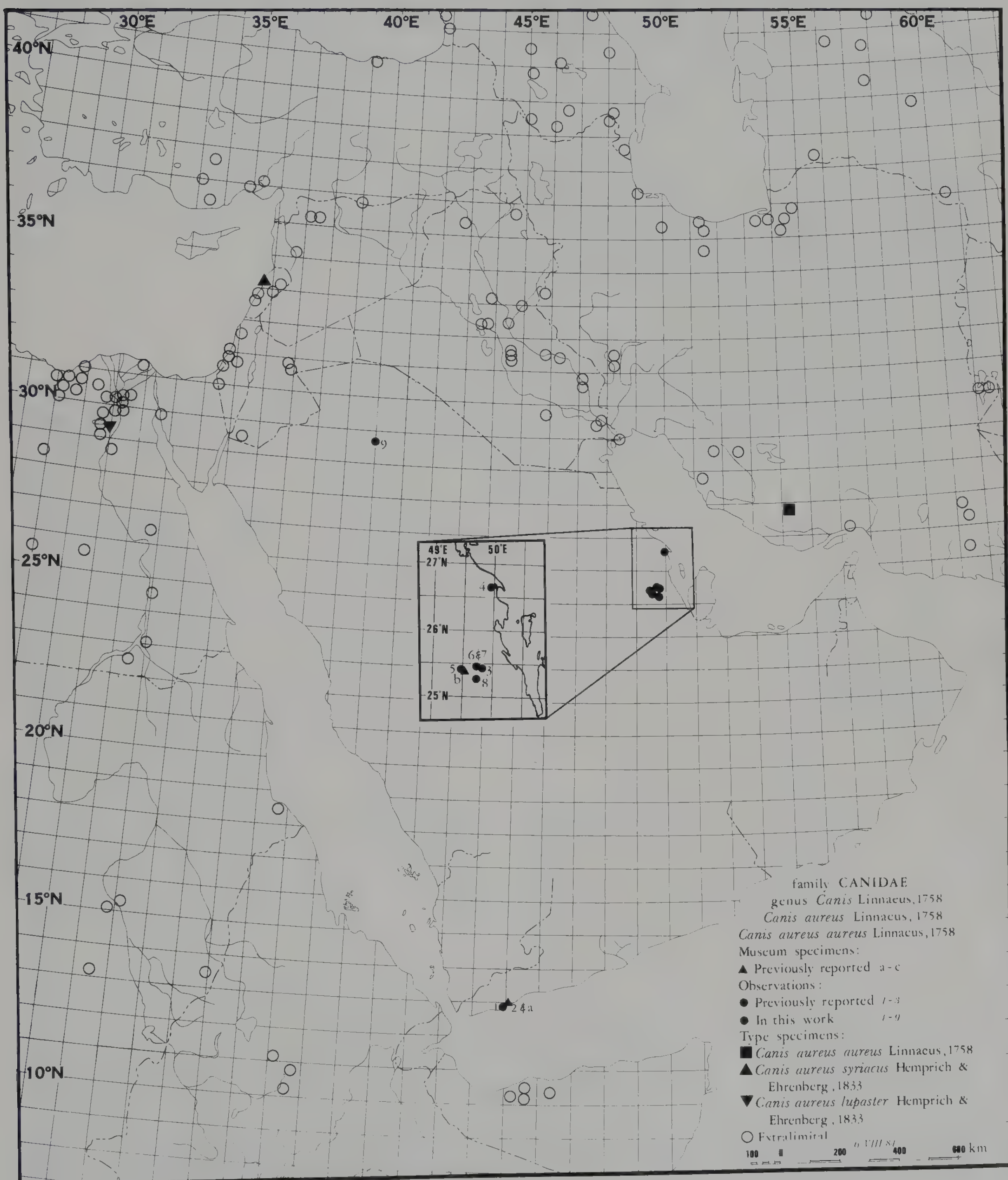


Fig. 1: Distribution map of jackal.

49°42'E, 150 m, WB; 6 & 7 – 1977 & 1978 at Jabal Qarah, 25°27'N 49°42'E, 150 m, WB; 8 – 3.IV.1983 nr Hofuf 25°16'N 49°42'E, 140 m, SB, AL; 9 – 19.II.1983 at Laija, 18 km S of Al Jawf 29°45'N 39°30'E, 670 m, live jackal, AAG.

***Canis lupus*** Linnaeus, 1758. **Wolf**

1758 *Canis lupus* Linnaeus: Syst. Nat. 10th Ed. *1:* 39, Sweden.

***Canis lupus pallipes*** Sykes, 1831

1831 *Canis pallipes* Sykes: Proc. Zool. Soc.: 100, Deccan, India.
1935 *Canis lupus pallipes* Sykes; Pocock, Proc. Zool. Soc.: 668.

***Canis lupus arabs*** Pocock, 1934

1894 *Canis pallipes* Sykes; Thomas, Proc. Zool. Soc.: 450, Muscat.
1897 *Canis lupaster* Hemprich & Ehrenberg, 1830 (1833); Matschie, S. B. Ges. Nat. Fr.: 73, Aden.
1899 *Canis pallipes* Sykes; de Winton, Proc. Zool. Soc.: 536, Aden.
1900 *Canis hadramauticus* Noack: Zool. Anz.: 356, Aden.
1926 *Canis lupus* ssp. (aff. *pallipes)* Schwarz, Senck. *8 (1):* 46, Aden.
1934 *Canis lupus arabs* Pocock: Ann. Mag. Nat. Hist. *14:* 636, Ain, Southern Arabia.

The wolf is larger and heavier built than the jackal, however, a young wolf can be mistaken for the latter, with a darker dorsal appearance and lighter sides. As a size example, Harrison (1968 p. 200), notes an adult male *C. l. arabs* from Buraida 114 cm total length of which the tail, typically rather short with scanty brush was 32 cm or 28% of total length.

Generally, the wolves in Arabia are of a pale sandy colour, however a colour description cannot be attempted because of tremendous variations. There are wolves that are best described as reddish, some light grey and others very dark. The wolf looks very much like an Alsation or police dog.

Formerly widespread in Europe including Britain. However, now extinct in Britain, Holland, Denmark, Belgium, France and Switzerland. Widespread but scarce in the rest of Eurasia, on the Indian subcontinent south to Dharwar. Widespread in north America. Heretofore, *Canis aureus lupaster* Hemprich & Ehrenberg, 1833 of Egypt and north Africa was considered to be a jackal. However, Ferguson (1981) presents a strong argument that the race *lupaster* is a race of wolf, not jackal, i. e. *C. lupus lupaster.*

In Arabia, the wolf is widespread and common in two races *C. l. pallipes* in the very northern reaches and *C. l. arabs,* a smaller animal in the south. The zone of gradation is not well defined. Dr. B. C. R. Bertram (in litt.) says that a wolf's food requirement is about 3 kg per day. He notes that surplus killing is rather rare and unusual behaviour but does occur when the predator finds itself in close proximity to prey animals that do not run away. In the case of domestic animals this usually happens as they are confined to a pen. The wolves are, of course, the nemesis of the Bedu since time immemorial. They do kill and eat sheep and sometimes kill more sheep than they can eat.

It would be a great pity to see the total demise of the wolf. There is a danger that this could happen with the use of strychnine. The wolf in north and south Europe and north America for example, is near extinction due to the pressure of stock-breeders and the use of poisons.

The wolf seems to be in no danger at the time of writing. It is known from the sea coasts to the highest mountain reaches. Undoubtedly, when sufficient small mammal prey is available, the wolf will not resort to preying on domestic animals.

Protection of the wolf is difficult. Certainly the use of poisons should not be permitted under any circumstances. The wolf's survival is no doubt a problem for the future. Large protected areas with good populations of wildlife are required to assure its long-term survival.

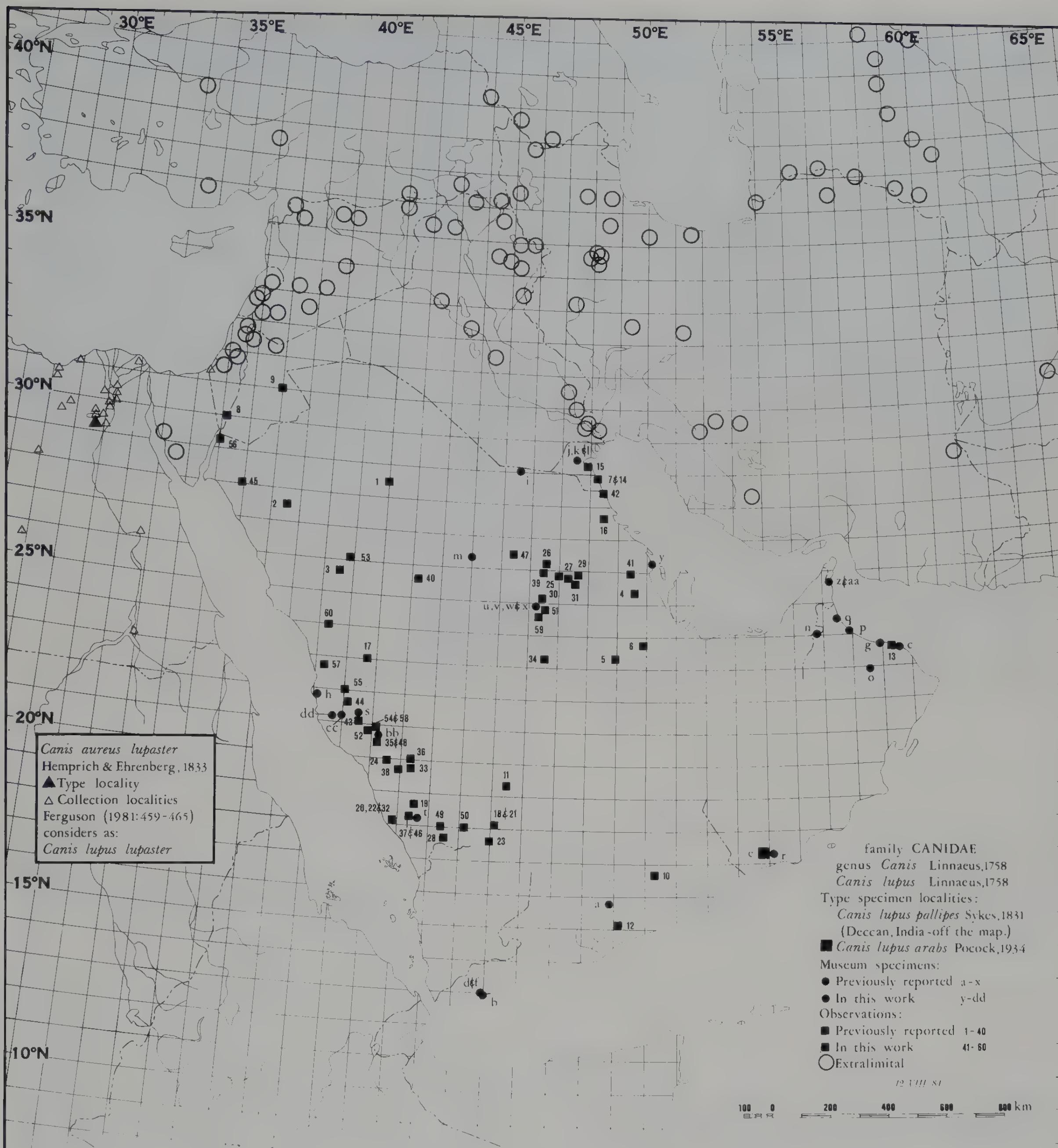


Fig. 2: Distribution map of wolf.

Records and map designations (fig. 2, table 2):

Previously reported: 1. Lady Ann Blunt, 1881 II p. 248; 2., 3. Doughty 1888 I p. 453, II p. 163; a) Noack, 1896 p. 356; b) De Winton, 1899 p. 536; c) Thomas, 1894 p. 450; d) Thomas, 1900 p. 101; 4.-6. Cheesman & Hinton, 1924 p. 550; e) Dollman, 1932 p. 339 and Pocock, 1934 p. 636; f), g) Pocock, 1935 p. 449; h) Morrison-Scott, 1939 p. 201; 7. Dickson, HRP, 1949 p. 41; 8., 9. Bromage, 1954 p. 703; 10., 11. Thesiger, 1959 pp. 199, 235; i)-q) & 12., 13. Harrison, 1968 pp. 202, 203; 14.-16. Dickson, V., 1970 pp. 96, 165, 239; r) Harrison, 1980 p. 392; s)-x) & 17.-40. & Nader & Büttiker, 1980 p. 410.

In this work: y – VIII.1946 CAS 9527 (skin only) btwn Al Khobar and Dammam 26°22′N 50°10′E, NSL shot wolf that killed 5 sheep the previous night, JG; 41 – late 1946 nr Ayn Dar 25°59′N 49°23′E, chased a pair of wolves that escaped on rocky jebel, JG; 42 – 1954 nr Khawr Khafji 28°27′N 48°28′E a wolf killed (teeth presented to H. H. Sheikh Abdullah Salem as Subah), JG; 43 – 1975-1976 km 25 Taif-Abha Rd 21°12′N 40°37′E, 1400 m, a "hanging tree" where many wolves (and occasionally a hyaena) were hung during this two year period, JPG; 44 – 15.I.1976 nr Zaymah 21°37′N 40°06′E wolf, DOR, JPG; z – 29.XI.1976 nr Dibba, Jebel Saatari 25°39′N 56°15′E HZM 9.8336, SBR, DHI; aa – 18.IV.1977 Quarayat (same location as z, above), HZM 10.8748, animal in zoo at Sib (see Taxonomic Table); 45 – 24.XI.1978 nr Shigri 28°02′N 35°54′E photographed dead wolf hanging in tree, WDL (WKL saw a wolf hanging in same tree in 1975, probably another "hanging tree"); 46 – 12.VIII.1980 summit Jabal Sawdah 18°16′N 42°22′E, 2900 m, photographs huge wolf hanging in tree, JJL, RLP, SP, PP and JPG; 47 – IX.1980 nr Artawiyah 26°31′N 45°22′E, 620 m, sighted live wolf, WB; 48 – 16.IX.1980 Wadi Turabah 20°29′N 49°12′E, 1470 m, ♀ wolf hanging in tree, WB; 49 – 20.IX.1980 Al Dalham 18°01′N 43°24′E, 2180 m, wolf DOR, WB; 50 – 25.IX.1980 Wadi Sanakhah 18°02′N 44°07′E, 1320 m, wolf DOR, WB; bb – 1980 Wadi Shuqub 20°40′N 41°15′E, skull, HZM 16.10685, WB; 51 – VIII.1981 Wadi Hanifah 24°45′N 46°35′E, 610 m, sighted live wolf, WB; 52 – 2.X.1981 Bani Saad 20°50′N 40°56′E, 2350 m, sighted live wolf, AA; 53 – II.1982 Harrat Khaybar 26°05′N 39°50′E, 4 live wolves sighted from helicopter, KF; 54 – 10.IX.1983 Wadi Qust 20°57′N 41°06′E, 1390 m, photographs of a wolf and 3 hyaenas hanging in tree, WB; 55 – 18.XI.1983 nr Al Majmaah 22°04′N 40°01′E, 900 m, red wolf hanging on fence post had killed 3 sheep week previous, JPG, SSN; cc – 16.II. 1981 km 121 Makkah by-pass 21°17′30″N 39°58′E, 305 m, wolf hanging on sign post, skull HZM 17.11819, JPG; dd – 2.XII.1983 km 75 Makkah by-pass 21°16′30″N 39°41′E, 170 m, dead wolf hanging on sign post, skull, HZM 18.13482, WDL, CLL, JPG; 56 – 8.II.1984 one mile south of Haql 29°17′N 34°57′E, live wolf running on track ahead of car, JWS, FK; 57 – 24.II.1984 Wadi Hanaq 22°44′N 39°15′E, 100 m, live wolf seen, DBM; 58 – 28.II.1984 Wadi Qust 20°57′N 41°06′E, 1390 m, ♀ wolf, just killed hanging in same tree as previous reports of this site, WB; 59 – 27.III.1984 between Al Mazahmiya & Dharma 24°30′N 46°15′E, report with photograph of a wolf chased with 2 cars until exhausted, beaten until it fainted, then captured, SG; 60 – 27.IV.1984 Jabal Warjan 23°59′N 39°16′E, live wolf seen from helicopter, ISC.

## Genus *Vulpes* Oken, 1816

Distinguished from *Canis* by smaller size, more slender form, shorter legs, long bushy tail and larger ears proportionate to the size of the head.

Dental formula: i $\frac{3}{3}$ c $\frac{1}{1}$ pm $\frac{4}{4}$ m $\frac{2}{3}$ = 42 (same as *Canis*).

### *Vulpes vulpes arabica* Thomas, 1902. **Fox**

1894 *Vulpes leucopus* Blyth; Thomas, Proc. Zool. Soc. : 450 (Jayakar, 1885) (Miles, 1887), Muscat.
1895 *Vulpes nilotica* Geoffroy (?); Yerbury & Thomas, Proc. Zool. Soc.: 548, Sheikh Othman.
1900 *Vulpes leucopus* Blyth; Thomas, Proc. Zool. Soc. *7:* 101, Sheikh Othman and nr. Shaka NW of Lahej (Percival & Dodson).
1902 *Vulpes vulpes arabica* Thomas: Ann. Mag. Nat. Hist. *10:* 489, BM (NH) 94.3.9.1, Muscat (Surg. Gen. ASG Jayakar).
1935 *Vulpes vulpes arabica* Thomas; Pocock, Ann. Mag. Nat. Hist. *(10) 15:* 450, Suk al Khamis and Quai'iya (Philby).

*Vulpes vulpes arabica,* which stands 35–40 cm at the shoulder, TL 60–92 cm, T 24–38 cm (ear 67–109 mm), is larger than the sand fox or the fennec and is certainly the most commonly seen carnivore in Arabia.

Plate 1: Fox, Wadi Khaytan, 8 km SW of Biljurshi. 1982 (Photo S. Collenette).

A pointed snout with prominent large ears, usually of a sandy grey colour overall with whitish underparts. A more or less distinct white tip on the long bushy tail and usually the backs of the ears are black or blackish, darker at the tips (Plate 1). By and large a nocturnal predator, it retreats into burrows, natural caves or crevices during the day. Its daily food requirement of ½ kg is mostly small rodents such as jirds and gerbils, though it also eats birds and their eggs, lizards, snakes and insects. Foxes also eat vegetables and fruits, being particularly fond of watermelons. Many foxes are killed on the roads at night as they scavenge for rodents and reptiles killed by traffic.

*Vulpes vulpes* is widespread in the Palaearctic region, except the far north, and in northern Africa from Morocco to Egypt and south to Sudan. In Arabia it is ubiquitous being present in large numbers and certainly benefiting from garbage and rubbish dumps which provide a permanent food supply or support food as well as shelter for many of its prey species. Research is needed to find out if, and to what extent, foxes influence populations of game birds, reptiles and small mammals.

Records and map designations (fig. 3, table 3):

Only museum specimens are numbered.

Previously reported: Blunt, 1881 II p. 248; Doughty, 1888 II p. 163; 1.–3. Thomas, 1894 p. 450; 4., 5. Yerbury & Thomas, 1895 p. 548; 6., 7. Thomas, 1900 p. 101; Cheesman & Hinton, 1926 p. 355; 8.–12. Dollman, 1931 p. 227; 13.–17. Pocock, 1935 p. 450; 18.–29. Morrison-Scott, 1939 p. 198; 30., 31. Sanborn & Hoogstraal, 1953 p. 237; 32.–60. Harrison, 1968 pp. 208–211; 61. Harrison, 1980 p. 392.

In this work: Animals reported hereunder except live animals are specimens that were examined for ecto-parasites and to determine whether it may be *V.v. arabica* or *V. rueppelli;* whether or not it may be suitable for a museum specimen and photographed and/or logged.

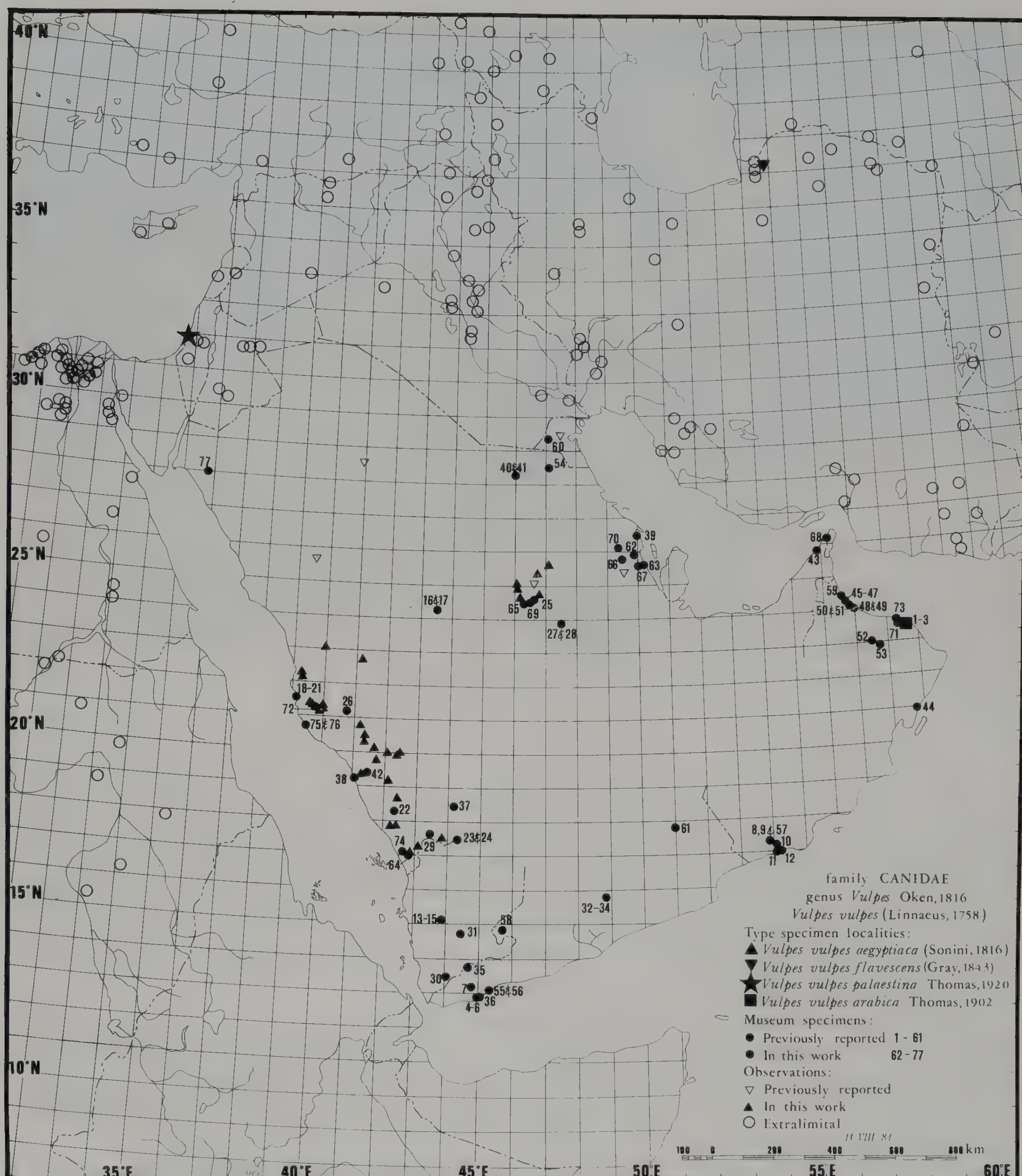


Fig. 3: Distribution map of fox.

62 – VI.1947 CAS 9528 Jabal Ayn Dar 25°56'N 49°53'E, ♀ with fetus, JG; 63 – c.XI.1945 CAS 9529 nr Al Uqayr 25°39'N 50°13'E, (skin only), JG; 64 – 9.X.1975 Hakimah (FAO camp) 17°01'N 42°50'E, 80 m, specimen killed and skinned for IAN collection (measurements not available) IAN, JG; 65 – 1975, 55 km W Riyadh 24°35'N 46°18'E, skull, HZM 35.8139, MCJ; 66 – 5.X.1975 at 25°47'N 49°32'E, specimen HZM 36.8273, DP(1); 67 – Jafura 25°37'N 50°10'E, specimen HZM 39.8620, GB; 7.II.1976 Riyadh Airport 24°40'N 46°41'E, 598 m, live fox seen, WB; 25.IV.1976 km 25 Al Baha– Al

Aqiq Rd, 20°11′N 41°39′E, pair of live foxes seen early a.m., JPG, BK; 10.III.1977 Jebel Buwayb 25°21′N 46°45′E, 700 m, live fox nr camp, WB; 18.VIII.1978 Wadi Khumrah 24°59′N 46°05′E, 900 m, 2 live foxes 13:00 hrs, WB; 30.IX.1978 Wadi ad Dilla 17°55′N 42°23′E, 340 m, DOR, ticks collected, WB; 9.X.1979 Wadi Tabalah 20°00′N 42°28′E, 1200 m, DOR, ticks collected, WB; 16.X.1979 Wadi Maraba 17°54′N 42°23′E, 320 m, DOR, ticks collected (colour slide), WB; 20.X.1979, 30 km W of Bisha 19°59′N 42°20′E, 1200 m, DOR, WB; 1.XI.1979 nr FAO camp, Hakimah 17°01′N 42°50′E, 80 m, live fox observed in spotlight, JG, RAF and RBF; 16.XI.1979 Rumah 25°37′N 47°07′E, 450 m, fox killed by Saluqi dog, ticks taken, WB; 20.II.1980 Wadi Dhi Khul 17°31′N 43°50′E, 2100 m, DOR, WB; 11.VIII.1980, 5 km N of An Nimas 19°09′N 42°07′E, fox DOR, JPG, RLP; 14.X.1980 Riyadh 24°40′N 46°11′E, 598 m, live fox in captivity, ticks taken, WB; 24.III.1981 Hakimah (FAO camp) 17°01′N 42°50′E, 80 m, live fox in citrus grove, JPG; 1.IV.1981 Wadi Shakub (Taif-Abha Rd), fox DOR, JPG; 25.XI.1981 Wadi Turabah 20°37′N 41°17′E, 1300 m, fox DOR, JPG; 8.XII.1981 Fayfa 17°15′N 43°06′E, live fox in coffee plantation, JG, YZ; 1982, km 50 Abha-Taif Rd 18°34′N 42°21′E, fox DOR, photographed, MN; 1982 8 km S of Biljurshi 19°45′N 41°42′E, 1900 m, flash photograph of live fox, ISC; 27.III.1983 km 173 Taif-Abha Rd 20°18′N 41°22′E, fox DOR, JPG; 20.V.1983, 29 km S of Mikhwah 19°18′N 41°14′E, fox DOR, JPG; 16.VI.1983 km 109 Taif-Abha Rd 20°49′N 41°11′E fox DOR, JPG; 22.XI.1983 Harrat Kishb 22°43′N 41°10′E, live fox photographed from helicopter WKL, DL; 13.I.1984 Wadi Mardum 22°16′N 39°14′E, 280 m, live fox observed, WB; I.1984, 3 km N of Amq, fox DOR, photographed, DB; 16.II.1984 Samran area at 23°05′N 39°58′E, 1158 m, live fox seen from helicopter, CL, RS; 68 – 21.II.1979 Khasab 26°11′N 56°15′E, HZM 42.10047, MDG; 69 – 10.XII.1978 SE Jabal Tuwaiq nr Riyadh 24°30′N 46°30′E, HZM 43.10145, DS; 70 – N of Ain Dar 26°08′N 49°24′E, HZM 44.10662, GB; 71 – IX.1980 Azaiba 23°36′N 58°22′E, HZM 45.11174, MH; 72 – X.1980 km 80 Makkah by-pass 21°15′N 39°43′E, 155 m, HZM 46.11197, JNH; 73 – 3.IV.1981 Qurum 23°37′N 58°37′E, HZM 48.11646, TL; 74 – 20.VIII.1980 nr Sabya 17°07′N 42°39′E, HZM 49.12339, ADA; 75 & 76 – 1983 nr Shoiba 20°45′N 39°30′E, NSL, LC 77 – III.1984 Jabal as Sinfa 27°57′N 35°47′E, 500 m, EDL, ISC.

Area of intensive study:

10.VI.1979–1.VIII.1984, 223 one-way trips were made to record the natural history of the road that traverses the desertic area from km 53 on the Jeddah-Makkah Rd 21°27′N 39°37′E, 190 m, going eastward in a semi-circle with a radius ± 25 km south of the Holy City of Makkah, to join the Makkah-Taif RD 127.5 km from Jeddah nr 21°19′30″N 40°01′E, 300 m. The lowest elevation on the road is about 150 m at km 81.5, 21°14′15″N 39°43′45″E; the highest at km 124 21°18′30″ 39°59′E, where the elevation is on the order of 315 m. Annual precipitation increases eastward with elevation. Something less than 100 mm in the lower western reaches to nearly 200 mm in the higher eastern sector.

During the five year study, which covered every month of the year, 160 species of flowering plants were photographically recorded; 143 species of birds were recorded with certainty (some photographed) including some rare migrants and stragglers on the occasional rain ponds; 7 species of snakes and 13 species of lizards were collected as well as 2 species of *Bufo;* incidentally, some insects as well as 2 species of scorpions. Mammals collected included the hedgehog *Paraechinus aethiopicus,* the jerboa *Jaculus jaculus,* the gerbils *Gerbillus nanus* and *G. cheesmani* and the Egyptian tomb bat *Taphozous perforatus.* The baboon, *Papio hamadryas* was recorded at km 126.5 on three occasions. The carnivora collected were *Felis catus, Felis silvestris, Hyaena hyaena, Canis lupus, Mellivora capensis* and the ubiquitous fox *Vulpes vulpes,* here listed (27 observations JPG unless otherwise noted):

1979: 9.VI. km 118, one fox; 23.VI. km 92, DOR; 3.X. km 70, DOR; 5.XI. km 70 & 111, live foxes xing rd, JAM; 1980: 4.I. km 92, live fox; 22.I. km 112.5 w/ISC; 26.III. km 121, DOR w/JJL; 1.V. km 118.5 & 121.5, DOR; 2.V. km 108.5, DOR; IX. km 80, skull collected, JNH; 1981: 1.IV. km 121,

DOR; 1.VI. km 90, DOR; 1982: 3.V. km 95, DOR; 18.VI. km 86, DOR, KGS; 29.IX. km 120, DOR; 22.X. km 92, DOR; 3.XII. km 83.5 & 88, DOR; 10.XII. km 1983, DOR; 17.XII. km 73.5, DOR; 1983: 18.VI. km 126.5, 3 live foxes flushed from burrows in cool sand of dried up rain pond; 26.XI. km 70, DOR w/RP.

### *Vulpes rueppelli sabaea* Pocock, 1934. **Rüppell's Sand Fox**

1825 *Canis rupeli* (sic) Schinz: Cuvier's Thierreich, *IV:* 508, Dongola, Sudan.

1826 *Canis famelicus* Cretzschmar in Rüppell's Atlas zu. d. Reise im Nördl. Afrika. Säugeth. *15,* Nubian Desert and Kordofan.

1931 *Fennecus* sp. Dollman in Thomas' "Arabia Felix": 227.

1933 *Cynalopex* sp. Dollman in Philby's "Empty Quarter": 394.

1934 *Vulpes rueppelli sabaea* Pocock: Ann. Mag. Nat. Hist. *14:* 636, Rub al Khali (Type specimen concluded to be the same animal noted by Dollman, 1931 and illustrated in Thomas' "Arabia Felix").

*Vulpes rueppelli* is smaller (TL 59–81 cm, T 26–36 cm, Ear 88–110 mm) than the common fox. The ears lack dark tips usually present on the common fox and are much larger proportionate to the head. The pelage is finer and softer, of uniform pale sandy colour. Harrison (1968 p. 213) describes a specimen (HZM 1.3733) as buffy yellow on the flanks with a distinct orange rufous dorsal stripe from the nape to the base of the tail which is a lighter hue, long and bushy, tipped whitish. Rufous rings around the eyes, white cheeks with black patches in front of the eye. The chin and ventral surfaces are white.

Its food requirements on average are about the same as the common fox or probably somewhat less (½ kg per day) reflecting its smaller size. In view of its habitat, often in extreme desertic conditions, it must gain from its prey in addition to its food requirements, its moisture needs, as well. Its basic food of small rodents and reptiles is no doubt augmented by some grasses and desert succulents for moisture

Plate 2: Rüppell's sandfox, Jiddat al-Harrasis, Oman. IV.1982 (Photo H. Jungius).

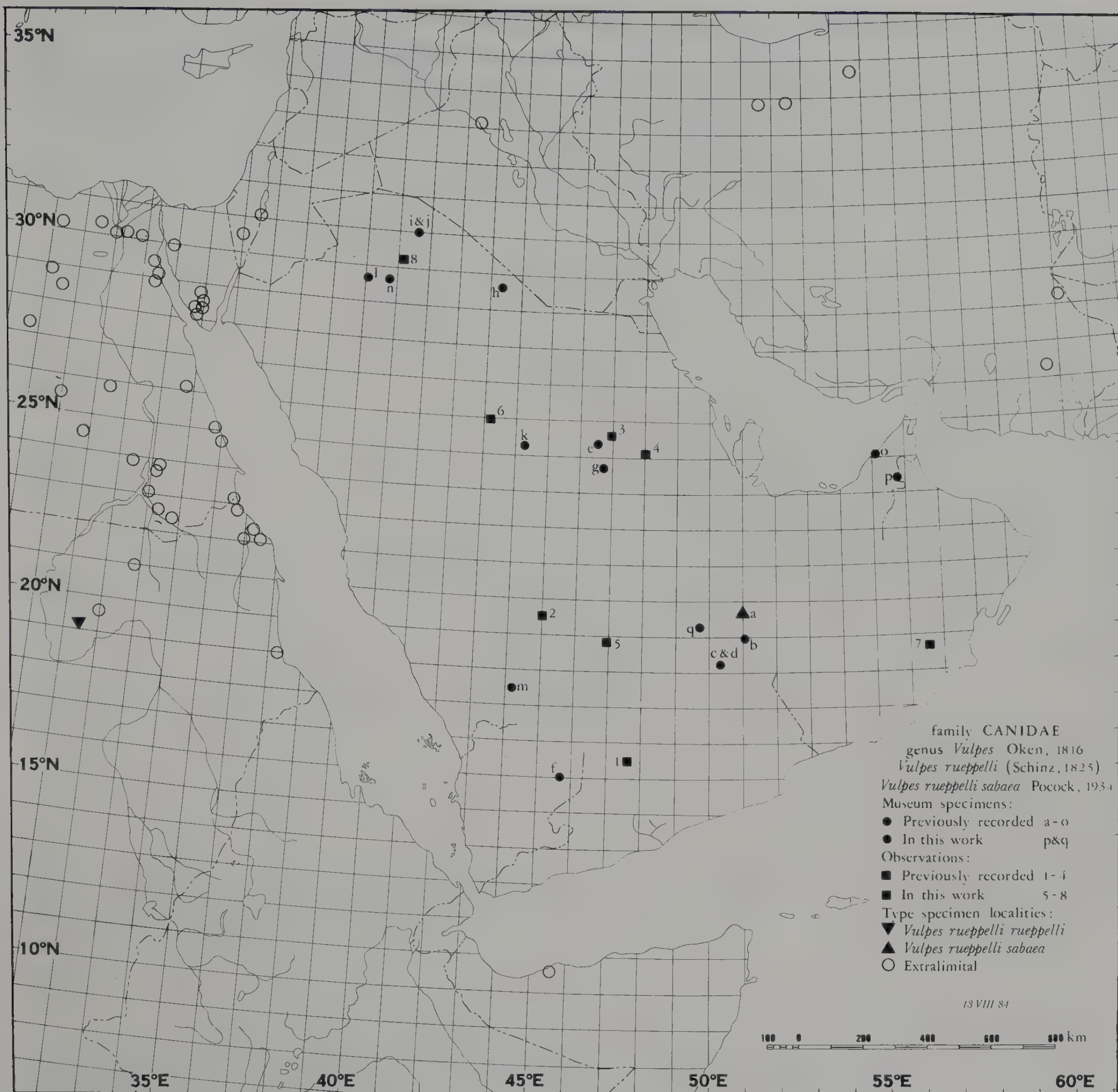


Fig. 4: Distribution map of Rüppell's sand fox.

content. It must find daytime shelter in deep burrows or caves and resort to strict nocturnal habit to conserve body moisture and maintain heat balance (see fennec).

Rüppell's fox is found in the deserts of northern Africa south to Sudan and Somalia. In Arabia it is widespread except on the Red Sea littoral and in the montane periphery.

The continued existence of this beautiful creature is a strong argument for the complete prohibition of the use of poisoned baits to control predators.

Records and map designations (fig. 4, table 4):

Previously reported: a) Dollman, 1931 p. 227, Pocock, 1934 p. 636, 1935 p. 452; b), c), d) Dollman, 1933 p. 394 and Pocock, 1935 p. 452; e), f), g) Morrison-Scott, 1939 p. 201; h), i), g) Lewis, Lewis & Harrison, 1965 p. 63; k), l), m), n) & 1.–3. Harrison, 1968 p. 215; o) Harrison, 1977 p. 19; 4. Vincett, 1982 p. 192.

In this work: 5 – 28.XII.1968 Irq abu Fakr 19°51′N 46°56′E, an animal believed to be a fennec, but possibly juvenile *V. rueppelli* captured alive but escaped before species could be determined, JG; 6–19.X.1981 Zilfi–Buraydah Rd c. 26°00′N 43°12′E, animal DOR, WB; p – VII.1977 Abu Dhabi–Oman border region c. 24°20′N 55°45′E, died in captivity XII.1979, HZM 3.10587, PD; 7 – II.1981 Yalooni 19°45′N 56°30′E, photographs HZM archives, MDG; q – 17.II.1982 Rub al Khali 20°16′N 49°42′E, skull HZM 4.12079, JM; 8–5.IV.1984 approx. 30 km N of Sakaka 30°10′N 40°20′E, KH.

## Genus ***Fennecus*** Desmarest, 1804

Dental formula: i 3/3 c 1/1 pm 4/4 m 2/3 = 42 (as in *Canis* and *Vulpes*).

Distinguished by small size, huge ears and pallid colour.

### ***Fennecus zerda*** (Zimmermann, 1780). **Fennec**

1777 *Vulpes minimus saarensis* Skjöldebrand: K. Svenska vet. Akad. Handl. Stockholm *38:* 267, Algerian Sahara. This older name is disqualified as the author assigned a trinominal.

1780 *Canis zerda* Zimmermann: Geogr. Ges. des Menschen *2:* 247, Sahara.

1804 *Fennecus arabicus* Desmarest: Dict. d'Hist. Nat. *24* Tabl. Math. Mamm. 18 (= *Canis zerda* Zimmermann).

This beautiful animal is indeed a small fox, weighing about one kg (TL 57 cm, T 20 cm, Ear 97 mm) identified by pale colour, large uniformly coloured ears and a short tail with a black tip. The fur is soft, long and silky, providing a good insulation from the desert heat (see below).

In Rüppell's fox the tail averages more than 70% of the HB length, while in the fennec the tail length is just over 50% of the head and body. Rüppell's fox has the tail tipped white; the fennec has a black tip on the tail.

In spite of this striking difference there has been great confusion differentiating between the juvenile Rüppell's fox and the fennec.

Schmidt-Nielsen (1965 pp. 126, 127) states that *Fennecus zerda* is the only Saharan carnivore that is entirely independent of drinking water. It "lives on a mixed diet consisting of insects,lizards, rodents and more plant material than is commonly consumed by carnivores. The animals dig rather deep burrows so that exposure during hot days can be kept to a minimum". Captive animals that ate scraps from the table, milk, meat and bread were especially fond of peaches and strawberries and used water for heat regulation and resorted to the panting mechanism of the dog for heat-water balance.

However, in the wild desertic conditions they depend on their burrowing and nocturnal habits plus the moisture content of their prey. About two thirds of animal organism is water, suggesting that carnivores would be independent of drinking water provided no water is used for heat regulation, i. e. panting and evaporation of moisture from the respiratory tract for heat dissipation.

Though little is known of the physiology of the fennec, it must be assumed that their kidneys are adapted to extremely high concentrations of urea with very little water loss in the excreta, a very high heat gradient through their luxuriant pelage and a tolerance of dehydration probably greater than that of a dog, which is of the order of 10 – 20% of body weight. The mystery of the function of the outsize ears vis-à-vis independence of water needs (such as the desert hare) yet requires explanation.

Schmidt-Nielsen's observations are, of course, applicable to the other carnivores in the desert, the wolf, hyaena, jackal, sand cat, sand fox, etc.

The fennec is distributed across the deserts of north Africa from Morocco through Algeria, Libya and Egypt south to Sudan and Sinai. In Arabia it would have been assumed not to exist except that Dame Violet Dickson sent a live specimen from Kuwait to the London Zoo in 1935 where it died in July of that year (Morrison-Scott, 1939 p. 199). However, Harrison (1968 p. 218) diagnosed the specimen as ♂ imm.

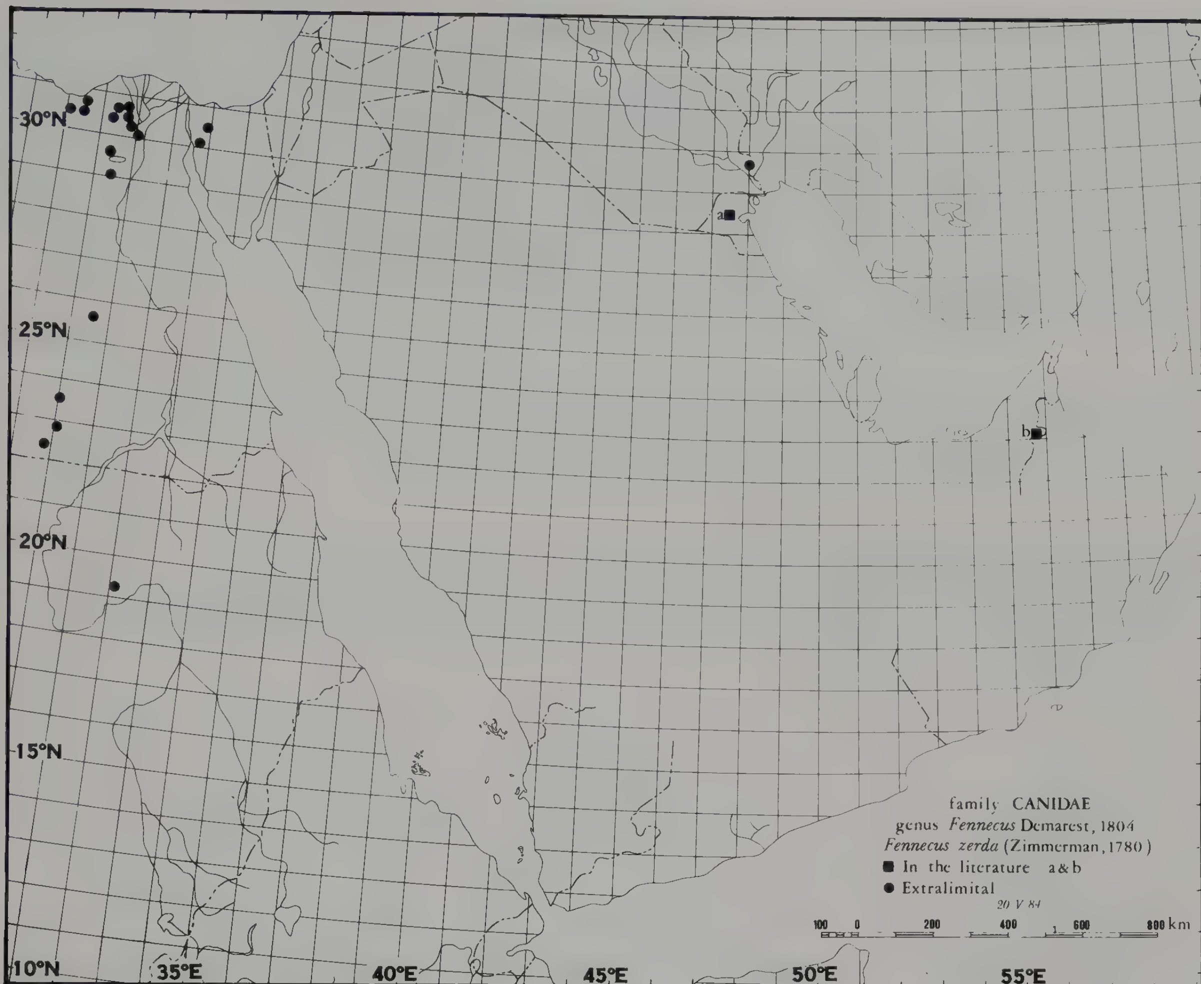


Fig. 5: Distribution map of fennec.

The senior writer, 28.XII.1968 travelling in the Rub al Khali near Irq abu Fakr 19°51′N 46°56′E with Sulaiman Munif ad Doseri, saw a fox run into a crevice in gypsiferous shale. The shale was removed and the fox was picked up by the scruff of the neck. It was taken back to Riyadh and thought to have been a fennec. Mike Ameen put it in a cage from which it escaped before it could be photographed or its true speciation determined. This record will always be a question mark as to whether it was, in fact a fennec or a juvenile Rüppell's fox.

More recently AlRobaae (1982 p. 61) reported a specimen of the fennec from Jabal Sanam 30 km NE of Basrah (30°42′N 48°02′E) as well as a living animal in the Al Ain Zoo from Jabal Hafit (24°03′N 55°46′E)*.

Records and map designations (fig. 5, table 5):

Previously reported: a) Dollman in Thomas' "Arabia Felix", 1932 App. II p. 340 and Harrison, 1968 p. 218; b) Al-Robaae, 1982 p. 62.

In this work: None.

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* Since this writing, Dr. A. D. Al Khalili visited the Al Ain Zoo and says the animal reported by Al Robaae from Jabal Hafit is not a fennec but is, in fact, *Vulpes rueppelli*.

## Fam. **Mustelidae**

### Genus *Mellivora* Storr, 1780

Heavy bodied, short limbs and tail. Coarse pelage, powerful digging claws on front feet. Distinctive colour pattern and enlarged anal glands producing nauseous secretion.

Dental formula: i 3/3 c 1/1 pm 3/3 m 1/1 = 32

### ***Mellivora capensis*** (Schreber, 1776). **Ratel or Honey Badger**

1776 *Viverra capensis* Schreber: Säugeth. pl. 125.

### ***Mellivora capensis wilsoni*** Cheesman, 1920

1920 *Mellivora wilsoni* Cheesman: J. Bombay Nat. Hist. Soc. *27:* 335. Type Ram Hormuz (Iran) (R. B. Woosnam).

1941 *Mellivora capensis wilsoni* Cheesman; Pocock, Mammalia *2:* 456.

### ***Mellivora capensis pumilio*** Pocock, 1946

1900 *Mellivora ratel* Sparrman; Thomas, Proc. Zool. Soc., Habil nr Aden (Percival & Dodson).

1935 *Mellivora ratel* Sparrman; Pocock, Ann. Mag. Nat. Hist. *(10) 15:* 447, Shaab Fuzul (Bertram Thomas).

1946 *Mellivora capensis pumilio* Pocock: Proc. Zool. Soc. *114:* 314. Type: Hadramaut (ARM Richards) London Zoo, 28.VII.1938, died 26.I.1945.

Medium sized (TL 78–93 cm, T 19–25 cm, Ear 27–35 mm) squat robust animal, unmistakably black and white. The ventral surface, limbs, muzzle, eyes and the tail distally are black, contrasting sharply with the white of the base of the tail, the back, neck and crown. This is an example of warning colouration. The muzzle is blunt, the eyes are relatively small. The ears are much reduced and inconspicuous, the external ear a mere ridge covered over with hair.

The ratel has anal glands capable of emitting a nauseating secretion as well as huge claws on its fore feet constituting a fighting and killing capacity out of proportion to its size. The claws on the forefeet of *Mellivora capensis* are illustrated by Pocock (1946 p. 317) (fig. 6 & 7) and Harrison (1968 p. 249), (fig. 8). Pocock notes "their curved fossorial claws measuring 30 mm in a straight line". The text figures by the two authors show huge claws, indeed. Pocock's figure of the claws of the type specimen of *M. c. pumilio* illustrate the claws of a captive animal that had not needed its claws to dig for its food, hence the curling; Harrison's figure shows the claws of an animal that subsisted in the wild. Its claws have not been degenerated. Harrison (1968 p. 245) says "The middle claw of the forefeet is 35 mm in length, 8 mm in depth at the base, the middle digit of the hindfoot smaller being about 14 mm ... the pelage is coarse and the skin is thick being impervious to poisonous snakes or porcupine quills".

A nocturnal animal, the ratel though widespread, is seldom seen. Philby, in his wide travels, did not collect the ratel nor does he mention it. Doughty (1888 II p. 164) mentions that an Arab told him of seeing one dead, "eth-thurramban – which I take to be a fabulous animal".

The ratel's food requirements, on the order of ½ kg per day, is gained by burrowing after its prey, probably made up mainly of lizards such as the spiny-tailed lizard (*Uromastyx aegypticus* and *U. microlepidota*) and the desert monitor (*Varanus griseus*). It also eats other reptiles, the young of other animals, rodents, birds, fish, beetles, arachnids, fruits and grasses. It is known in parts of its range as the honey badger for its habit of attacking bees nests to eat the honey and the bees as well.

The ratel is widespread in Africa from the Cape to Sudan in the east and west to Morocco south of the Sahara. In Asia it is found in the Levant and Palestine east to Turkmenia and Afghanistan, in Nepal and in India.

In Arabia the ratel is widespread, *M. c. wilsoni* in the north and *M. c. pumilio* in the south with intergrading of the races somewhere in the northern part of the peninsula.

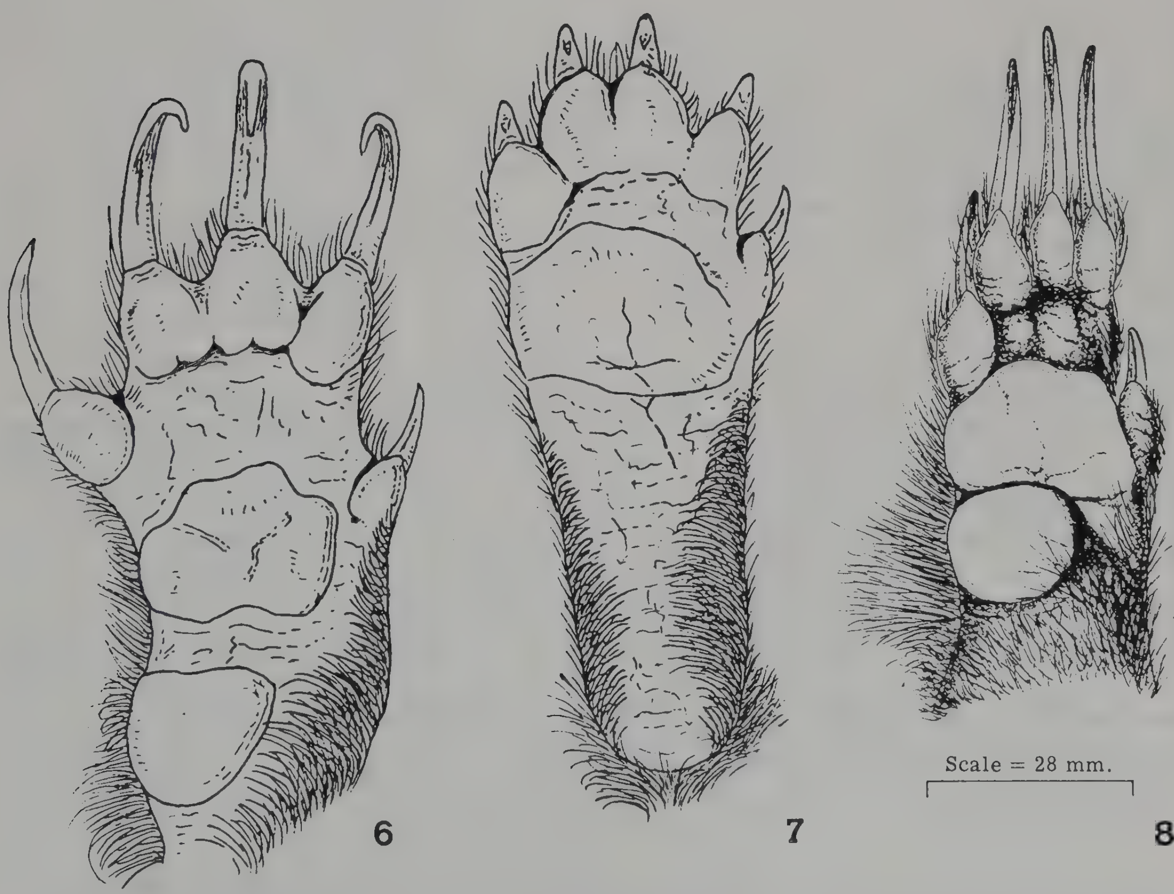
In spite of its adeptness at defense and being a formidable predator, the ratel easily succumbs to the pressure of man. Once, its unmistakable spoor and signs of its digging for its prey were commonly seen in the desert. This is no longer so. However, Dr. J. Burchard (pers. comm. WB) said that he has seen several near Qatif in recent years. It may be that the ratel has moved out of the desert that has been criss-crossed by oil exploration and production activities, highway construction and other pursuits of man, into the cover of irrigation ditches, abandoned hand dug wells and the vegetation of the oases.

The ratel needs the protection that would be afforded by proposed parks and nature reserves. Poisoning for predator control would spell the doom of this species, a fierce, noble, beautiful animal.

Records and map designations (fig. 9, table 6):

Previously reported: 1. Doughty, 1888 II p. 164; a), b), c) Thomas, 1900 p. 101; 2. Cheesman & Hinton, 1924 p. 551; d) Dollman, 1931 p. 227; e) Pocock, 1946 p. 314; 3. Dickson, 1949 p. 465; 4. Thesiger, 1949 p. 38, 1959 p. 260; f) Lewis & Atallah, 1966 p. 390; g), h), i), j), k) Harrison, 1968 p. 246.

In this work: 5 – 1945–47 Ayn Dar 25°59′N 49°23′E, unmistakable spoor on many occasions, JG; 6 – spring 1964 nr Ar Rass 25°51′N 43°31′E, pair of ratels in Wadi ar Rimah in early evening, JG, RL; 7 – II.1976 Hakimah 17°01′N 42°50′E, 80 m, captured ♀ juvenile, PDM, transported to zoological garden at King Faisal Military City, given to Capt. Musallim Shaman, probably same animal depicted in




Figs 6–8: 6, lower view of the right fore foot of *Mellivora capensis pumilio* (from Pocock, 1946 p. 317). Natural size. 7, lower view of right hind foot of the same (fig. 6) (from Pocock, 1946 p. 317). 8, right forefoot of *Mellivora capensis wilsoni,* from Nuhaidam near Thumail, Iraq (from Harrison, 1968 p. 249).

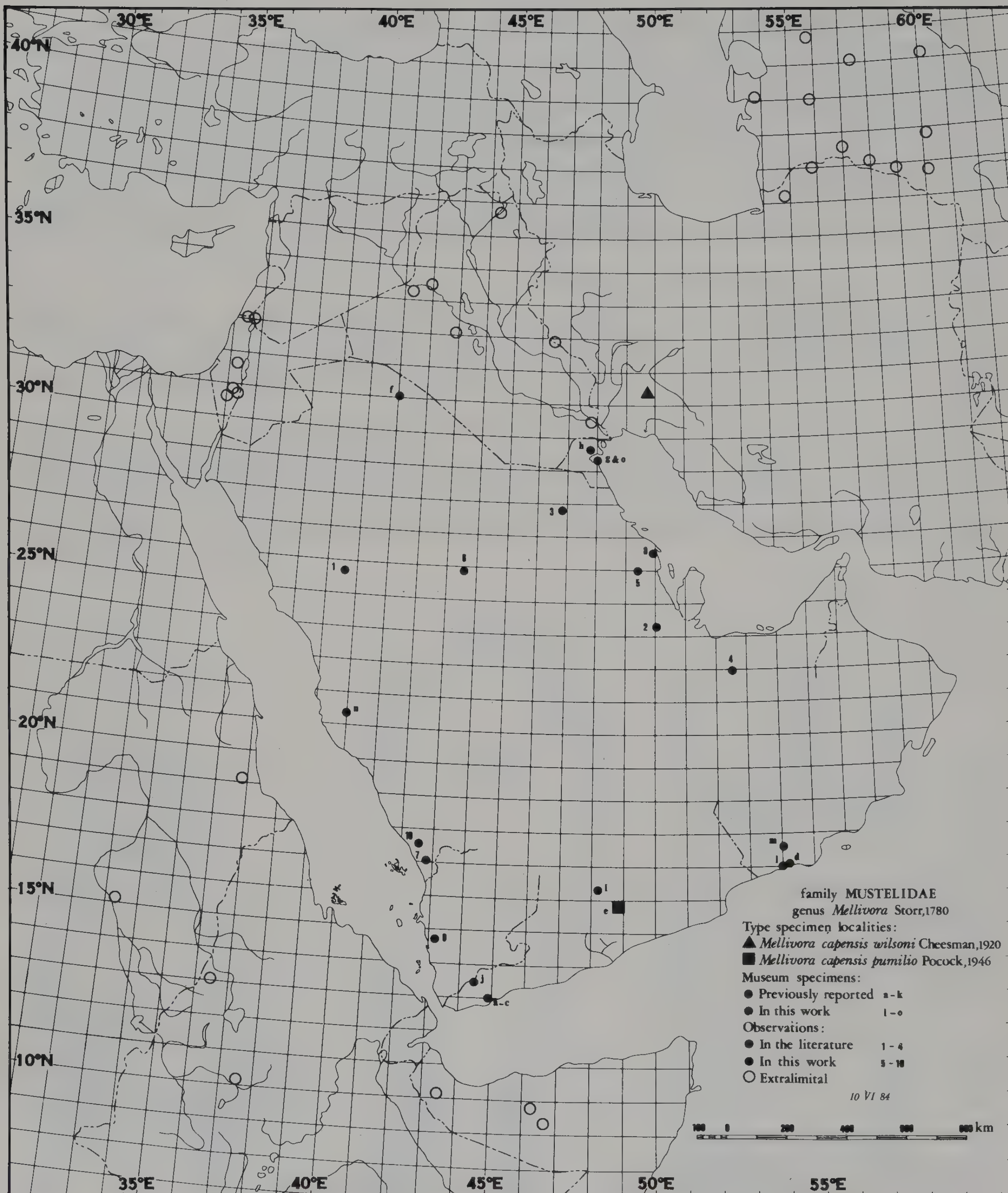



Fig. 9: Distribution map of ratel or honey badger.

VINCETT (1982 p. 188), PG; 8 – 1982 vic. Qatif 26°33'N 49°59'E, NSL, sightings on several occasions, JEB; 10 – early 1982, 2 mi N Wadi Baysh 17°23'N 42°33'E, ratel DOR, ISC; l – 24.II.1979 Salalah 17°01'N 54°04'E, imm., ONM, AB; 9–25.I.1982 betwn Zabid & Bait al Faqih 14°46'N 43°11'E, DOR, KB; m – 1981 Thamarit (locality not confirmed 17°39'N 34°02'E, HZM 3.12055, JNB, MDG; n – c. 22.V.1985 km 125 Makkah by-pass 21°18'30"N 40°00'E, 300 m, photographed, skull saved, CLL, JPG; o – 26.V.1985 specimen in Kuwait to Nat. Hist. Mus. Kuwait, photo in Al Anba newspaper.

## Fam. **Viverridae**

### Genus ***Herpestes*** Illiger, 1811

Elongated body and neck, pointed muzzle, short limbs and low broad ear concealed in the fur. Coarse pelage, tail long, tapered distally.

Dental formula: i ⅗ c ⅟₁ pm ⁴⁄₄ m ⅖ = 40.

***Herpestes edwardsi*** (Geoffroy St. Hilaire, 1818). **Indian Grey Mongoose**

1818 *Ichreumon edwardsii* E. Geoffroy St. Hilaire: Desc. de l'Egypte *2:* 139, «East Indies» (Madras, Pocock, 1933).

***Herpestes edwardsi ferrugineus*** Blanford, 1874

1874 *Herpestes ferrugineus* Blanford: Proc. Zool. Soc.: 661 pl. 81, Larkhana, Sind.
1937 *Herpestes edwardsi ferrugineus* Blanford; Pocock, Jour. Bomb. Nat. Hist. Soc. *39:* 242.
1939 *Herpestes edwardsi ferrugineus* Blanford; Morrison-Scott, Novit. Zool. Tring. *41:* 198, Uqair (Philby).

The Indian grey mongoose is a small animal (TL 71–74 cm, T 30–37 cm, Ear 12–18 mm) long, slender with short legs, small rounded ears and long bushy tail tapered to the rear. The pelage is coarse, uniformly coloured. The individual hairs are annulated with creamy white and black bands appearing as tawny yellowish grey speckled with greyish white, the tail has a creamy white terminal pencil. The under fur is rustbrown showing through on the nape, shoulders, flanks and outer thighs as well as on the muzzle, cheeks and margins of the ears.

The mongoose is omnivorous. Its food requirements, of the order of ¼ kg daily, are made up of an extremely varied diet including arachnids, scorpions, beetles as well as other invertebrates, fish, amphibians, reptiles, small rodents, birds, carrion and refuse. This animal is almost wholly diurnal, usually not found except in date palm groves, gardens and other well watered, verdant habitats.

*Herpestes edwardsi* is found from the Malay States (where it was introduced) westwards to the Indian subcontinent, Afghanistan, Pakistan and Iran. In Arabia, where it was probably introduced, it occurs in Kuwait, Bahrain, the Al Qatif and Al Hasa oases areas and at Al Oquair.

There is little danger of extinction of the mongoose, more likely an extension of its present range may occur, because it adapts well to living near human habitations and it thrives on human refuse which suits its omnivorous diet.

*Herpestes auropunctatus pallipes* (Blyth, 1845), the small Indian mongoose, with a distribution similar to *H. edwardsi*, above, much smaller (TL 41–54 cm, T 54–65 cm) widespread along the rivers in Iraq, may have, at this writing, extended its range to Bahrain. Certain small mongooses have been noted and though they may have been juvenile *H. edwardsi*, their colouration, though fleetingly observed, indicated *H. auropunctatus* (Dr. John Hunt, pers. comm., JG).

*Herpestes ichneumon*, the Egyptian mongoose, a larger animal (TL 94–103 cm, T 38–49 cm) is found in north Africa from Morocco to Egypt south to Sudan and Ethiopia and from Kenya and Nigeria to the Cape in South Africa. It is also known from Spain and Portugal and southeastern Turkey, Syria, Pal-

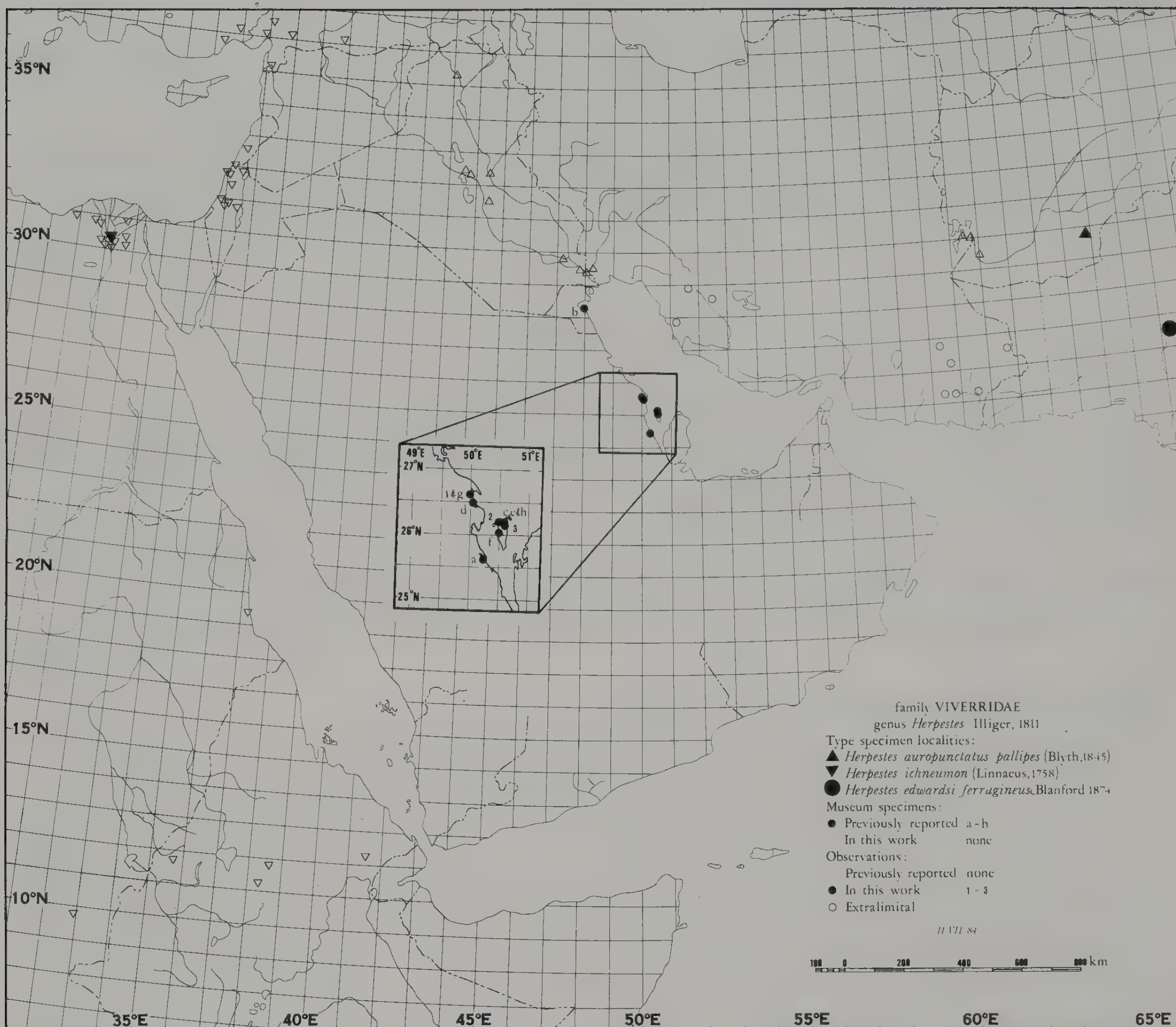



Fig. 10: Distribution map of Indian grey mongoose.

estine and Jordan (probably Lebanon as well). Its range expansion southward to the northwestern parts of the peninsula is a possibility.

Records and map designations (fig. 10, table 7):

Previously reported: a) Morrison-Scott, 1939 p. 198; b) Harrison, 1968 p. 266; c) Harrison, 1971 p. 116; d) Harrison,, 1971 p. 116; d) Harrison, 1972 p. 628; e), f) Gallagher & Harrison, 1975 p. 414; g) Nader, 1979 p. 312.

In this work: 1 – 1982 Al Qatif 26°36′N 49°59′E, “few sightings”, JEB; 2 – 1.I.1983 Al Budaiyah 26°12′N 50°27′E, live mongoose in mid-afternoon, JPG; 3 – 1.I.1984 nr Madinat Isa 26°10′N 50°34′E, live mongoose midday, AW, JG.

## Genus *Ichneumia* I. Geoffroy St. Hilaire, 1837

A genus of one species as described below.

Dental formula: i 3/3 c 1/1 pm 4/4 m 2/2 = 40

***Ichneumia albicauda albicauda*** (G. Cuvier, 1829). **White-tailed Mongoose**

1829 *Herpestes albicaudus* G. Cuvier: Regne Anim. Ed. 2, *1:* 158, Senegal.

1833 *Herpestes leucurus* Hemprich & Ehrenberg: Sym. Phys. Mamm. *II:* h, pl. 12.

1837 *Ichneumia albicauda* (G. Cuvier); I. Geoffroy St. Hilaire, Ann. Sci. Nat. Paris (Zool.) *8:* 251.

1894 *Herpestes albicauda* G. Cuvier; Thomas, Proc. Zool. Soc.: 450, Khode, Rui and Muscat (ASG Jayakar).

1895 *Herpestes* sp. (inc. probably *H. albicauda* Cuv.) Yerbury & Thomas, Proc. Zool. Soc.: 548, "seen at Haithalhim»" (Yerbury).

1968 *Ichneumia albicauda albicauda* (G. Cuvier); Harrison *2:* 266.

The white-tailed mongoose (TL 80–106 cm, T 26–42 cm approx.) is a rather large mongoose. Pelage is dense and long, bushy tail tapering to a point with coarse hairs 85–90 mm long. Dorsal surface, crown, ear fringes and top of base of tail grizzled greyish, muzzle and chin dusky brown, thin blackish ring around the eye with dark stripe from corner of the eye to corner of the mouth. Snout pointed, blackish. Feet are almost black. Cheeks buffy whitish; the tail lightens distally, the terminal third being pure white. HARRISON (1968 p. 267) notes that in Africa melanism is common and the distinctive white tail may be black. The underparts are brownish (Plate 3).

Like other mongooses, it is omnivorous, its food requirement of ¼ to ½ kg per day consists of reptiles, molluscs, small mammals and birds, berries and fruit and a great number of insects. Mainly nocturnal they are often seen in the early morning or late evening as well.

Widely distributed in Africa south of the Sahara. In Arabia it is known from the montane periphery from the latitude of Wadi Turabah/Al Lith (20°30′N) southwards reportedly seen in Aden and known from Dhofar and Oman.

The mongooses are among the most successful species, being adaptable to the encroachment of man on their habitat. However, many are killed on the roads, especially when foraging for insects near the corpses of camels or donkeys or other animals that have been killed by traffic. Many animals suffer this fate including hyaenas, foxes, genets, hedgehogs and also owls and vultures particularly *Gyps fulvus*.

It would be well to appeal to the authorities concerned that in such cases, the cadaver would be towed free of traffic so that such wildlife dependent on dead animals for their livelihood might be able to obtain their food in relative safety.

Plate 3: White-tailed mongoose, Hakimah, SW Saudi Arabia. 1981 (Photo P. Luhas).

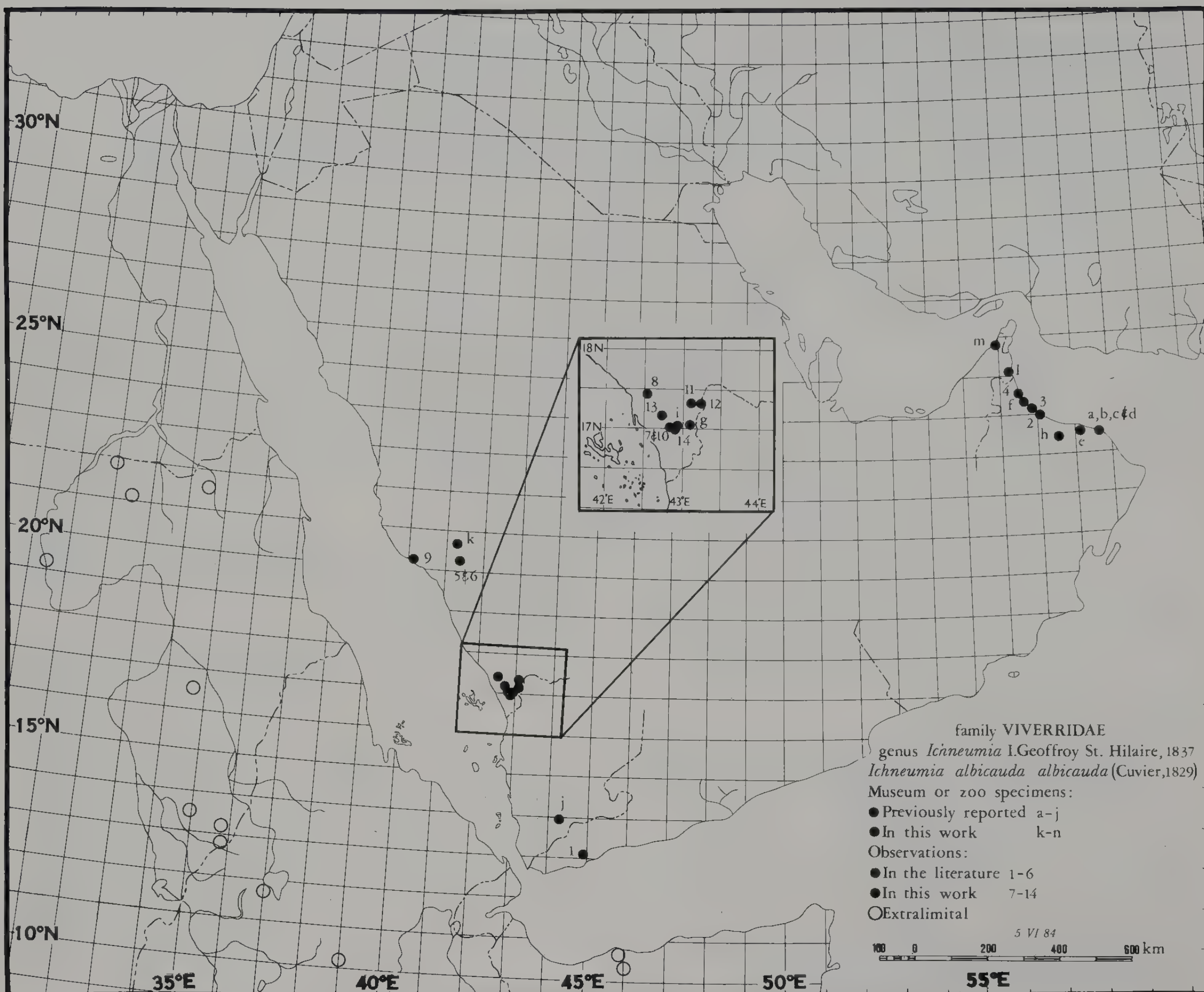



Fig. 11: Distribution map of white-tailed mongoose.

Records and map designations (fig. 11, table 8):

Previously reported: a), b), c), d), e) Thomas, 1894 p. 450; 1. Yerbury & Thomas, 1895 p. 548; 2., 3., 4. & f) Harrison, 1968 p. 268; g) Nader et al., 1975 p. 231; h) Harrison, 1977 p. 16; 5., 6. & i), j) Nader, 1979 p. 313.

In this work: 7 – III.1976 Hakimah 17°01′N 42°50′E, 80 m, live mongoose seen in mid-afternoon, PG; 8 – 5.V.1979, 46 km S Ad Darb 17°25′N 42°31′E, 50 m, 2 mongooses DOR nr dead donkey, JPG; k – 31.III.1980 Taif-Abha Rd nr Wadi Turabah 20°37′N 41°17′E, 1400 m, mongoose DOR, tail and part of mandible HZM 3.1178 JPG; 10 – 10.VI.1981 Al Lith 20°09′N 40°17′E, NSL, mongoose DOR nr dead camel, RP; 11 – 1981 Hakimah 17°01′N 42°50′E, 80 m, flash photograph of live mongoose, PL; 12 – 1982 nr Sukh Abyan 17°19′N 43°05′E, flash photograph of live mongoose, ISC; 13 – mid 1982 nr Bani Malik 17°19′N 43°14′E, flash photograph of live mongoose, ISC; 13 – X.1983 btwn Sabya & Sukh Abyan 17°11′N 42°45′E, 3 mongooses DOR, photographed, ISC; 14 – IX.1983, 6 km E of Abu Arish 16°57′N 42°53′E, mongoose DOR, photographed PM, DSW; 1 & m – c. 1980 Fujayrah 25°09′N 56°15′E & Ras Al Khaymah 25°48′N 55°56′E, living specimens in Al-Ain Zoo & Dubai Zoo, respectively, in litt. 5.I.1981 PD, DLH; n – V.1980 unknown locality "near Taif", live mongoose caught in jump trap, right front leg amputated, external measurements made (see Taxonomic Table), living in Al Rafia Menagerie, Jeddah, JPG, IGM; 3.IX.1984 live mongoose in USGS Camp nr Bani Sar 20°13′N 41°27′E, 2180 m, observed in good light, JPG.

### Genus ***Genetta*** Oken, 1816

Long bodied animals with soft fur vividly marked with dorsal spots and stripes. Short legs, ears tall and narrow, pointed muzzle, long bushy tail marked by contrasting pale and dark rings.

Dental formula: i 3/3 c 1/1 pm 4/4 m 2/2 = 40

### ***Genetta felina*** Thunberg, 1811. **Genet**

1811 *Genetta felina* Thunberg: Kongl. Svenska Vet. Akad. Nya Handl. *32:* 165.

### ***Genetta felina granti*** Thomas, 1902

1902 *Genetta grantii* Thomas: Ann. Mag. Nat. Hist. *(7) 10:* 487, Azraki Ravine, Haushabi (G. W. Bury).
1968 *Genetta genetta granti* Thomas; Harrison, "Mammals of Arabia" *2:* 270, Suk al Khamis (G. W. Bury).
1979 *Genetta genetta granti* Thomas; Nader, Senck. Biol. *59* (5/6): 315, 3 km S of Wadi Samra & Al Jawa (J. Gasperetti).
1983 *Genetta genetta granti* Thomas; Barnes, J. S. A. Nat. Hist. Soc. *2* (3): 38.

Slender, long bodied animal with short legs, ears tall and narrow, tail long and full (TL 837–920 cm, T 417–500 cm), a black dorsal stripe from the shoulders to the base of the tail; ground colour olive-grey with fulvous red spots and streaks on the flanks, a black median stripe on the forehead bordered with white each side, sides of the muzzle and the throat are white; the chin and lower lip blackish, the tail is ringed with 11 or 12 black rings. The under parts and inner limbs are greyish white (Plate 4). Mainly a nocturnal creature, its food requirements, in the order of ¼ kg daily, is made up of birds and their eggs, reptiles and amphibians, small mammals and insects. It also eats fruits, berries, vegetable matter and refuse. It readily climbs trees for its prey, though it is mainly a terrestrial animal.

Plate 4: Genet, Wadi Khaytan, 8 km SW of Biljurshi. 1982 (Photo S. Collenette).

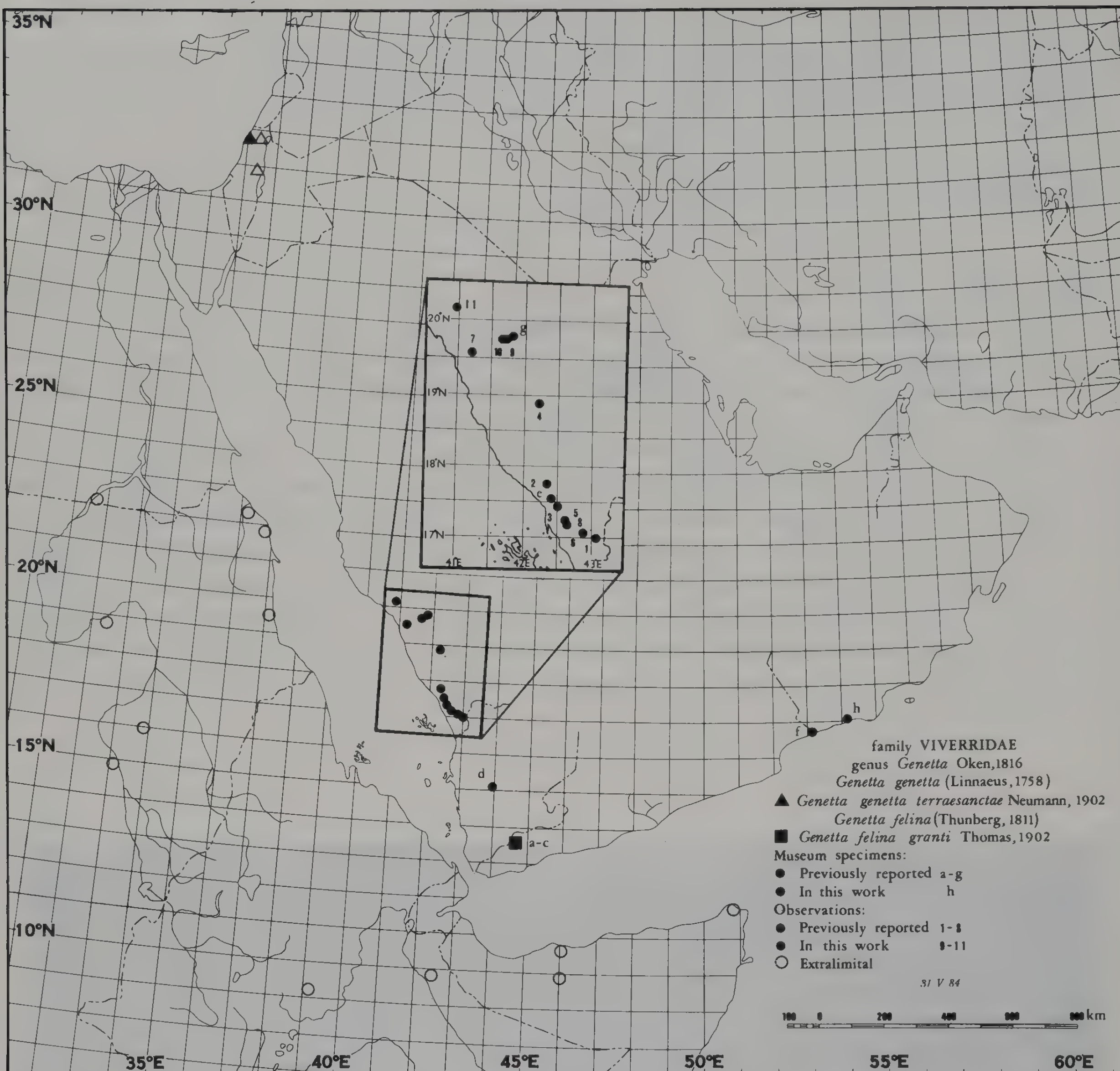



Fig. 12: Distribution map of genet.

Another closely related species *Genetta genetta terraesanctae* Neumann, 1902 is found in Palestine from Jerusalem to Jericho; somewhat larger than *Genetta felina granti.* A slight range extension southward may show this species to be in the peninsula's northwestern reaches.

The genets are distributed across southern Europe, north Africa and are widespread in Africa south of the Sahara. In Arabia *G. f. granti* is known from somewhat further north than Biljurshi-Mikhwah (latitude 20°N) south to South Yemen and in Dhofar. It is usually associated with semi-perennial water sources and well wooded and vegetated wadis. It is not found near populated places like the mongoose, but in a more sylvan habitat.

Records and map designations (fig. 12, table 9):

Previously reported: a) – c) Thomas, 1902 p. 487; d) Harrison, 1968 p. 273; e) & 1. Nader, 1979 p. 315; f) Harrison, 1980 p. 391; g) & 2.–8. Barnes, 1983 p. 39.

In this work: 9–17.IV.1983, 8 km S of Biljurshi 19°45′N 41°42′E, 1900 m, flash photograph of live genet, ISC; 10 – early 1982, Wadi Khaytan 19°45′N 41°40′E, 820 m, live genet in camp, ISC; h – II.1979 Wadi Arbat 17°06′N 54°08′E, skin ONM examined by DLH, TH; 11 – 23.II.1985 Wadi Alayb 20°07′N 40°53′E, 100 m, DOR, JPG & 25.IV.1985, live animal in car head light, PJ, JG.

## Fam. **Hyaenidae**

### Genus ***Hyaena*** Brisson, 1762

Distinguished by a dorsal mane extending from head to root of tail and pattern of 8 or 9 vertical black stripes on the body and transverse bars and spots on the legs. It has a lumbering gait when running – its forelegs being about 20% higher than the hindquarters.

Dental formula: i $\frac{3}{3}$ c $\frac{1}{1}$ pm $\frac{4}{3}$ m $\frac{1}{1}$ = 34

***Hyaena hyaena*** (Linnaeus, 1758). **Striped Hyaena**

1758 *Canis hyaena* Linnaeus: Syst. Nat. 10th edition *1:* 40.

***Hyaena hyaena syriaca*** Matschie, 1910.

1910 *Hyaena syriaca* Matschie: S. B. Ges. Nat. Fr. Berlin: 54–57, Antiochia, Syria (Antakya, Turkey).
1934 *Hyaena hyaena syriaca* Matschie; Pocock, Proc. Zool. Soc.: 819.

***Hyaena hyaena sultana*** Pocock, 1934

1895 *Hyaena hyaena* (Linnaeus); Yerbury & Thomas, Proc. Zool. Soc.: 548, Bir Ahmed (seen by M. C. Chevallier).
1900 *Hyaena hyaena* (Linnaeus); Thomas, Proc. Zool. Soc.: 100, Habil (Percival Dodson).
1934 *Hyaena hyaena sultana* Pocock: Proc. Zool. Soc.: 813. Type spec. Ain, Qara Mts. (Bertram Thomas).

Plate 5: Striped Hyaena, Jebel Qidam (26°32′N 48°50′E). Specimen sent to San Diego Zoo in 1947; died in 1958 (Photo Zool. Soc. San Diego).

*Hyaena hyaena syriaca* has not been collected in Arabia at this writing. However, specimens subsequently collected in the northern reaches of the peninsula may be of this race.

The hyaena cannot be mistaken in the field, relatively large (TL 146–159 cm, T 24–28 cm only about 27%). The tail is short. It stands higher on its forelegs than its hind legs (see also figs 13 & 14). The front height being accentuated by a blackish dorsal mane, the coarse hairs of which are as long as 20 cm middorsally. The pelage is of rather coarse hairs. The flanks have 8 or 9 vertical black stripes and transverse blackish bars and spots on the legs. The ground colour is grey to whitish grey, dusky grey muzzle, with buff yellow below the eyes, a black patch on the throat upwards to the sides of the neck, the nape has a black streak each side of the nuchal crest. The ears are rather tall, narrow and black on back. The short tail is black and white. Ventral surfaces a dirty white (Plate 5). Younger animals are more vividly coloured.

13

14

Figs 13–14: 13, left fore foot of *Hyaena hyaena sultana,* from Bani Sar (HZM 5.10967), coll. 14.VIII.1980. 14, left hind foot of *Hyaena hyaena sultana.* Same specimen as fig. 13. Drawings natural size.

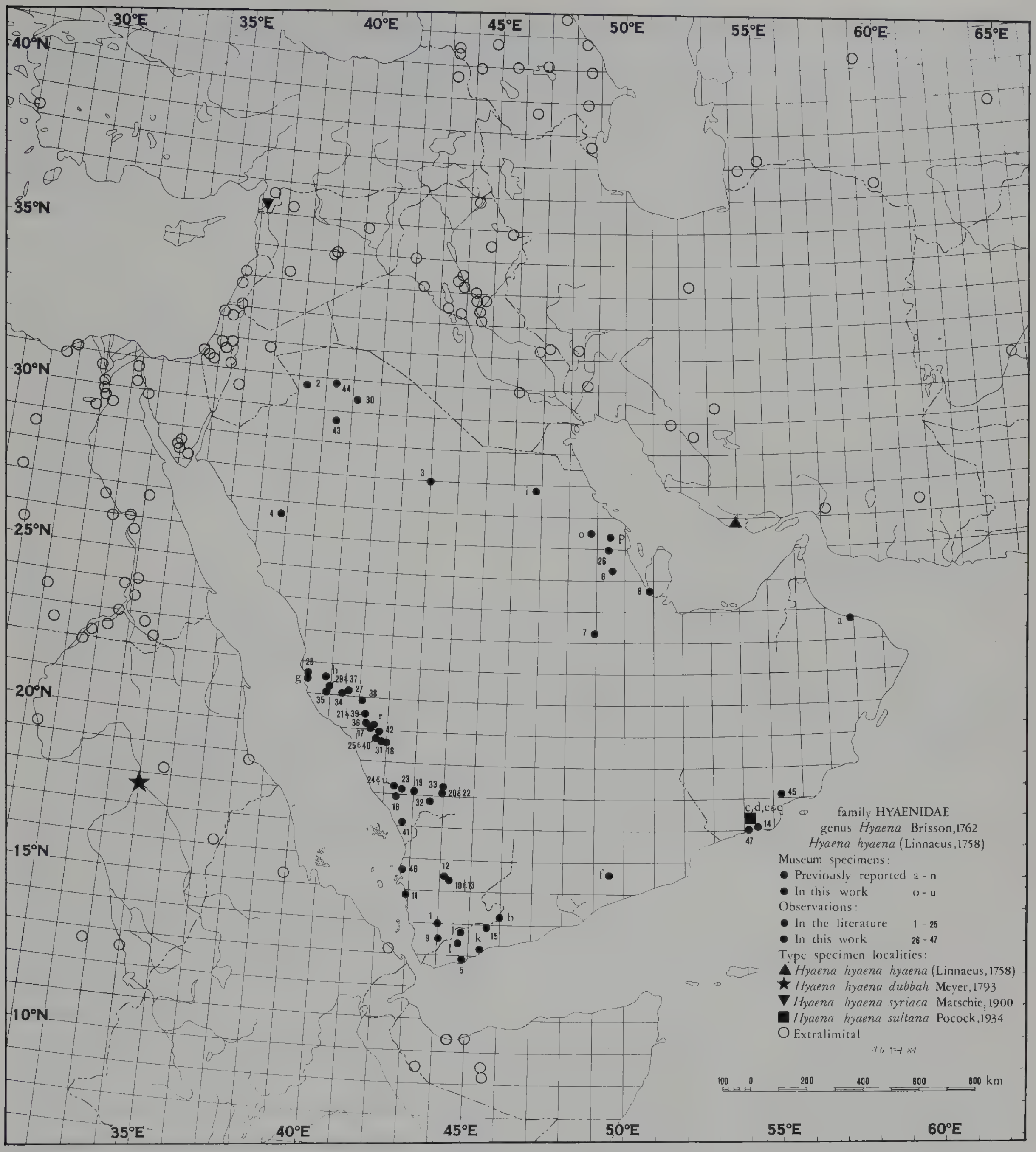



Fig. 15: Distribution map of striped hyaena.

Solitary, nocturnal animals, hyaenas live in caves and burrows where there is shelter from mid-day heat. At night they forage for carrion. The hyaena is omnivorous. Its food requirement of 2–3 kg per day includes vegetable matter, insects, reptiles and refuse as well as carrion. It is said that if carrion or other food is not available the hyaena will kill goats or sheep or even animals as large as a horse, donkey or camel. The very powerful jaws seemingly would enable the animal to do so, but it is unlikely that the hyaena resorts to killing of live animals except when on the verge of starvation.

Distributed across North Africa and south to Sudan, Ethiopia and Kenya; Asia Minor from Turkey to southern Russia east to Kashmir and south to the Nilgiri Hills in India. In Arabia it is widespread in two races *H. h. syriaca* in the north and *H. h. sultana* in the south. The area of intergradation is not known. There is not yet a museum specimen of *H. h. syriaca* from the reasonable geographic limits of the peninsula, but it is very possible that specimens from the northern reaches, i. e. Tabuk, Al Jawf, Sakaka, Turayf, may be of this race.

The hyaena is the object of much local superstitious belief, it is generally loathed as it has the reputation of being a grave robber.

At this writing, the human pressures on the species are immense. Unlike the canids, the wolves and foxes, the hyaenas lack cunning. It is easily brought to bait, easily tracked. They are not often seen abroad. However, the many reports of dead hyaenas hanging in trees and on sign posts, indicate they are being killed by baiting, tracking and trapping. The hyaena is a good candidate for the endangered species list in Arabia. It has been almost completely exterminated in much of its desert range where it was easily chased by motor vehicles and run over, run to death or shot. More and more of them are killed on the highways at night. Wanton killing of hyaenas must be banned immediately. Poisoning could exterminate the species in a very short time. The continued existence of the hyaena is in question.

Records and map designations (fig. 13, table 10):

Previously reported: 1. Botta, 1841 p. 65; 2., 3. Lady Ann Blunt, 1881 I p. 97 & II p. 55; 4. Doughty, 1888 I p. 203; 5. Yerbury & Thomas, 1895 p. 548; b) Thomas, 1900 p. 100; 6., 7. Cheesman, 1926 p. 354; c) Pocock, 1934 p. 636; d), e) Pocock, 1934 p. 814; 9., 10. Scott, 1942 pp. 93, 132; 11.–13. Sanborn & Hoogstraal, 1953 p. 238; 14. Thesiger, 1959 p. 179; a), f), g), h), i), j), k), l) & 15. Harrison, 1968 p. 277; m), n) & 16.–25. Nader & Büttiker, 1983 p. 503.

In this work: p – c. 1946 Jabal Lidam 26°22′N 43°27′E, CAS 9530, Ad ♂ captured alive, died in captivity, JG; 26 – c. 1946 Jabal Ayn Dar 25°59′N 49°23′E, 160 m, captured by Bedouin, died in captivity few months old, JG; o – 1947 Jabal Qidam 26°32′N 48°50′E, juv ♀ captured alive sent to San Diego Zoo where it died in 1958, JG; 27 – 2.VII.1976 km 25 Taif-Abha Rd 21°12′N 40°37′E, 1450 m, dead hyaena in "hanging tree", JPG; 28 – c. 1973 Jabal Burrayman 21°39′N 39°14′E, 100 m, mane of hyaena killed "nearby", JPG; 29 & 37 – V.1979 km 120.5 Makkah by-pass 21°17′15″N 39°57′45″E, 305 m, dead hyaena hanging on traffic signal & 10.V.1983 km 121 Makkah by-pass 21°17′30″N 39°58′E, 305 m, hyaena hanging on traffic sign (yng ♂ HB 1040 HF 190 FA 390 E 140), JPG; 30 – 26.V.1980 nr Ash Shuwayhitiya 30°23′N 40°08′E, 1100 m, live hyaena xing Rd at midnight, JG; 31 – 19.IX.1980, 28 km E of Namrah 19°45′N 41°40′E, 800 m, dead hyaena hanging in tree, JPG; r – 14.VIII.1980 nr Bani Sar 20°08′N 41°45′E, 2075 m, ♀ hyaena killed by traffic, skull saved HZM 5.10967 RLP, SP, PP, JJL, JPG; 32 – 25.I.1980 At Talhah 17°47′N 43°31′E, dead hyaena hanging in tree, photographed, RF; 33 – 29.XI.1981 btwn Wadi Qatan & Masane 18°10′N 43°58′E, 1750 m, dead hyaena, wolf and hyrax hanging in tree (hyrax skull to HZM), HAK, JPG; 34 – 22.IV.1983 Taif-Shafa Rd 21°07′N 40°22′E, 2050 m, dead hyaena hanging in tree, KGE, PE, JPG; 35 – 29.IV.1983 km 99 Makkah by-pass 21°10′30″N 39°51′E, 250 m, feet and fragments of skin of hyaena neatly lashed to sign post, photographed, JPG; 36 – 16.VI.1983, 22 km N Bani Sar on Taif-Abha Rd 20°13′N 41°22′E, dead hyaena hanging on pole in village, JPG, MMH; 38 – 22.IX.1983 Wadi Qust 20°57′N 41°06′E, 1350 m, colour slide of 3 hyaenas and a wolf hanging in tree, WB; 39 – 23.IX.1983 Wadi Turabah 20°29′N 41°12′E, 1470 m, 7 dead hyaenas hanging in a tree, WB; 40 – 13.X.1983 Wadi Hibaka 38 km SE Biljurshi 19°39′N 41°47′E, photograph of hyaena hanging on a sign post, ISC; 41 – 21.I.1984 Sabya – Abu Arish Rd 17°07′N 42°40′E, 4 captive hyaenas, DSW; 42 – III.1984 Wadi al Dilfah 19°56′N 41°40′E, 1800 m, photographs of dead hyaena hanging in tree, JEG, WB, AG; 43 – Laija 15 km S Al Jawf 29°40′N 39°30′E, 670 m live hyaena, AAG; 44 – Jabal al Amad in Al Harrat 30°55′N 39°20′E, live hyaena, AAG; 45 – X.1980, 60 km SW

Marmul nr 18°08'N 55°16'E, colour photograph of live hyaena MB, MDG; 46 – 5.II.1982 Wadi Mawr 15°41'N 42°42'E, live hyaena seen, KB; 47 – X.1976 nr Rayzat 17°01'N 54°17'E, colour photographs of hyaena DOR, RHD; s, t & u – Al Maski 35 km SE of Abha, Al Sarhan 22 km SE of Abha and Al Suda 18°16'N 42°22'E, 2800 m, skulls IAN 706, IAN 772 & IAN 838, in litt. IAN, WB; q – Salala-Thamarit Rd (Jabal Qara) 17°20'N 54°02'E, topotype HZM 4.9565; v – early 1985 km 91 Makkah by-pass 21°14'30"N 39°49'E, 245 m, dead hyaena, skull saved, WB; w – km 114 Makkah by-pass 21°15'N 39°55'E, 305 m, dead hyaena, skull saved, JPG (last 2 specimens not shown on map).

## Fam. **Felidae**

### Genus ***Felis*** Linnaeus, 1758

Wildcats, light and slender in build, ears high and triangular.

Dental formula: i 3/3 c 1/1 pm 3/2 m 1/1 = 30

***Felis silvestris*** Schreber, 1777. **Wild Cat**

1777 *Felis (Catus) silvestris* Schreber: Säugeth. *3:* 397, Germany.

***Felis silvestris tristrami*** Pocock, 1944

1895 *Felis maniculata* Rüppell; Yerbury & Thomas, Proc. Zool. Soc.: 547.
1900 *Felis maniculata* Cretzschmar; Thomas, Proc. Zool. Soc.: 100.
1933 *Felis ocreata* Dollman: in Philby's "The Empty Quarter" : 394, Umm al Qurun (Philby).
1935 *Felis ocreata* Dollman; Pocock, Ann. Mag. Nat. Hist. *(10) 15:* 455, Umm al Qurun (Philby).
1939 *Felis constantina syriaca* Tristram; Morrison-Scott, Novit. Zool. Tring : 197, Iraq Well & 15 mi NE Jiddah (Philby), 15 mi N of Jeddah (A. G. Griffin).
1944 *Felis lybica tristrami* Pocock: Ann. Mag. Nat. Hist. *11:* 125, Ghor Seisaban, Palestine.
1953 *Felis silvestris tristrami* Pocock; Haltenorth, Die Wildkatzen der Alten Welt : 45.
1968 *Felis silvestris tristrami* Pocock; Harrison, Mammals of Arabia *2:* 281.

***Felis silvestris iraki*** Cheesman, 1920

1920 *Felis ocreata iraki* Cheesman: Journ. Bomb. Nat. Hist. Soc. *27:* 33, Kuwait.
1968 *Felis silvestris iraki* Cheesman; Harrison, Mammals of Arabia *2:* 283.

***Felis silvestris gordoni*** Harrison, 1968

1968 *Felis silvestris gordoni* Harrison: Mammals of Arabia *2:* 283, Wadi Suwera, Oman (Capt. A. French-Blake).

The ancestral cat of most domestic cats. It looks like a domestic cat, but is larger with a shorter black ringed tail with a black tip (TL 80–120 cm, T 25–40 cm, Ear 55–67 mm). It stands 25–35 cm at the front shoulder. Ground colour yellowish grey with whitish throat and creamy underparts. Black stripes on forehead and neck merging to vertebral black stripe with transverse black bars running to the belly. Male larger than the female weighing on average 5 kg, the latter 3½–4 kg. Two distinct parallel black streaks on each cheek, nose-pad pink, iris greenish yellow, pupils vertical; ears small pointed with small tufts; soles of feet are black. Wild cats are nocturnal and seldom seen. Their daily food requirement of about ½ kg is almost wholly of live prey, birds, reptiles and small mammals. They are formidable killers.

Their general distribution is wide, including Scotland, southern Europe, the Balearic Islands, Sardinia and Sicily and north to Switzerland and Germany; in Eastern Europe, in Asia as far north as southwestern Russia, east to Mongolia and south to western India. In Africa except extreme desert areas and the rain forests.

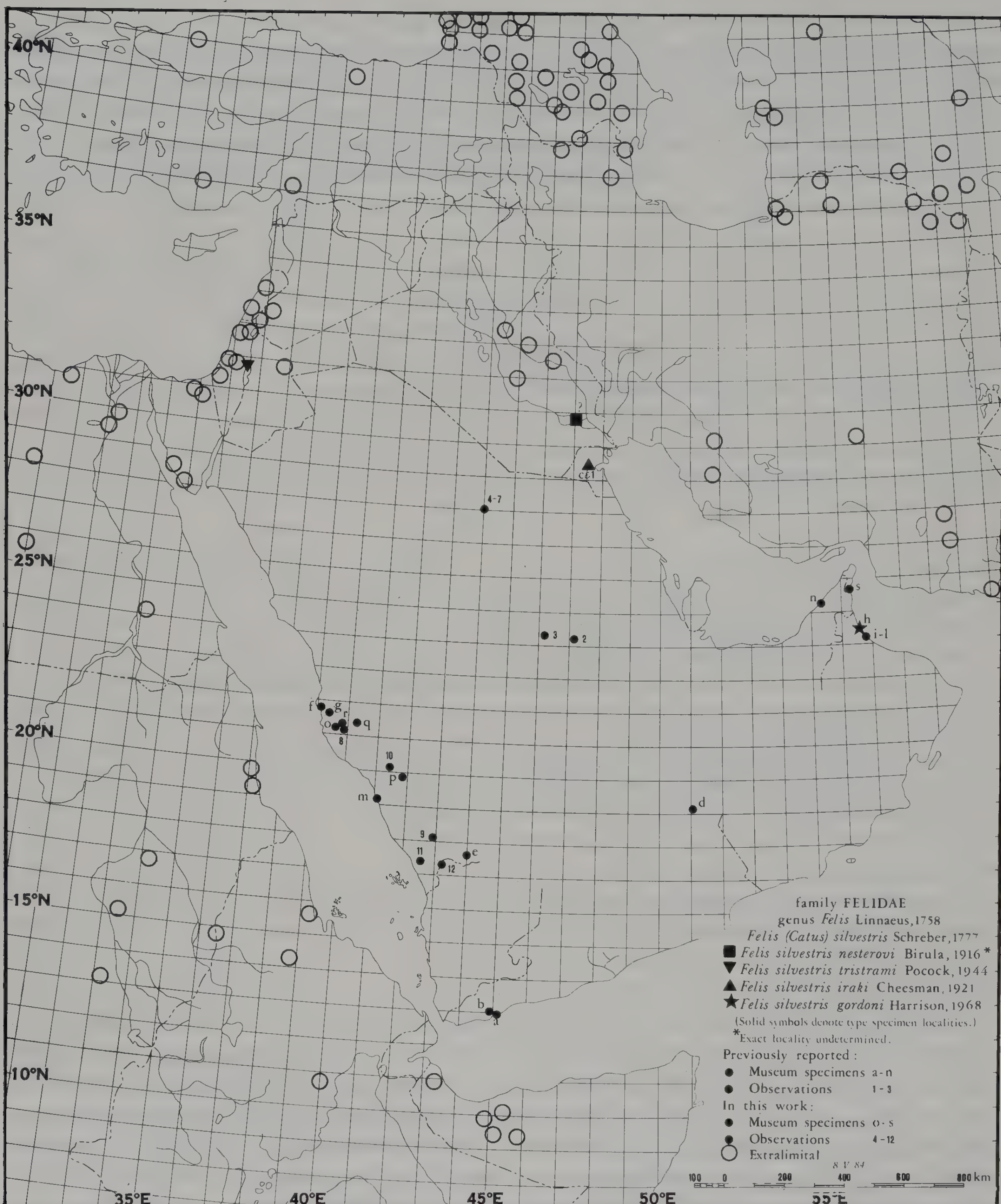



Fig. 16: Distribution map of wild cat.

Their distribution in Arabia is widespread. They mingle with feral domestic cats to some great extent. Hybrid specimens are common. *Felis silvestris* is more common in wooded areas and near water. However, a specimen was taken in the Rub al Khali (PHILBY, 1932). HARRISON (1971 p. 118) notes a specimen from Dubai in the desert littoral, while Burchard (in litt.) recorded several specimens from near At Taysiyah in desertic conditions.

It is virtually impossible to distinguish *Felis silvestris* from similar looking *Felis catus* in the field. Only a number of taxonomic characteristics can separate them. This fact poses a conservation problem, as well as having been a taxonomic problem for almost 100 years. It is highly desirable to investigate the impact of feral cats on birds, reptiles and small mammals, and to determine measures for their control.

Records and map designations (fig. 16, table 11):

Previously reported: a) YERBURY & THOMAS, 1895 p. 147; b) THOMAS, 1900 p. 100; c) CHEESMAN, 1920 p. 331; d) DOLLMAN, 1933 p. 394; e), f), g) MORRISON-SCOTT, 1939 p. 197; 1. DICKSON, 1949 p. 465; h), i), j), k), l), m) HARRISON, 1968 pp. 283, 284; n) HARRISON, 1971 p. 117, 2., 3. VINCETT, 1982 p. 208.

In this work: 4 – 7.I.1979 At Taysiyah 28°00′N 44°00′E, 580 m, 4 sightings in vicinity, one wild cat killed by saluki dog, two photographed, JB; o – 13.VIII.1979 km 91.5 Makkah by-pass 21°14′15″N 39°40′E, 240 m, DOR skull to HZM, JPG; 8 – 31.VII.1980 km 101 Makkah by-pass 21°10′N 39°51′30″E, 235 m, wild cat flushed from abandoned sheep shelter late afternoon, JPG; 9 – 29.IX.1980 Wadi Hizwah 18°05′N 43°56′E, 1450 m, dead wild cat hanging in tree, WB; p – 26.XI.1981, 40 km SE Biljurshi 19°49′N 41°51′E, 1900 m, wild cat DOR, skull HZM 20.12017, JPG; 11 – 26.I.1982 Wadi Samra 17°33′N 42°24′E, wild cat kitten captured brought to zoo at KSU-CE, Abha, RP, TW, JG; q – 25.III. 1983 km 50 Makkah-Taif Rd. 21°21′N 40°14′E, 880 m, wild cat DOR, skull to HZM, JPG; 12 – XI.1983 nr Bani Malik 17°19′N 43°14′E, flash photograph of wild cat, ISC; n – 6.I.1984 km 88 Makkah by-pass 21°14′N 39°47′E, 250 m, wild cat DOR, skull to HZM, JPG; 10 – 19.III.1981 Bani Sar 20°07′N 41°27′E, 2280 m, DOR ♂, ES; s – 1982 nr Bay'ah (N of Dibba, UAE) 25°39′N 56°16′E, skull, HZM, possibly large *F. catus*, DLH.

### ***Felis margarita*** Loche, 1858. **Sand Cat**

1858 *Felis margarita* Loche: Rev. Mag. Zool. *10,* 2: 49, pl. 1, nr Negonca, Algeria.

### ***Felis margarita harrisoni*** Hemmer, Grubb & Groves, 1976

1976 *Felis margarita harrisoni* Hemmer, Grubb & Groves: Z. f. Säugetierk. *41 (5):* 301, HZM 2.4747 ♂ Umm as Samim 21°55′N 55°50′E, 2.VII.1967 (P. Smith).

Unlike *Felis silvestris* all the other Felidae in Arabia are endangered species. Like the hyaena they are most susceptible to baiting and trapping.

The cats are among the most beautiful animals, one of the most striking is *Felis margarita,* the sand cat.

A small cat with a broad face, head and body length 39–55 cm, tail 23–34 cm. The ears are large, broad, set low with black tips; eyes with greenish-yellow iris and vertical pupils; nose pad dark brown, cheeks marked with fulvous red streak; ground colour pale sandy isabelline with indistinct vertebral stripe and spots, under parts and inner limbs whitish; the tail, half the length of the body, is distally ringed with the tip black.

Especially adapted to desert life, with the soles of its feet entirely covered with hairs to ease walking over sandy areas. It appears to shun built up areas and population centers.

Little is known of the biology and status of this remarkable little animal. "Short legs and low set ears strike a low profile, an advantage to a predator in sparsely vegetated areas" OSBORN & HELMY (1980

p. 447). Their food is probably birds, reptiles and small rodents, as well as varied insects. Their known habitat in Arabia, which indicates that they live without any source of water, is coincidental with that of the sand skinks (*Scincus* sp.) and *Phrynocephalus arabicus*, a tiny burrowing Agamid, which probably contribute greatly to their food requirements, of the order of ¼ kg per day.

Its distribution area covers North Africa probably southeastern Iraq and southwestern Iran north to the Transcaspian region in southern Russia and east to Pakistan.

In Arabia it is probably more widespread than collection records indicate.

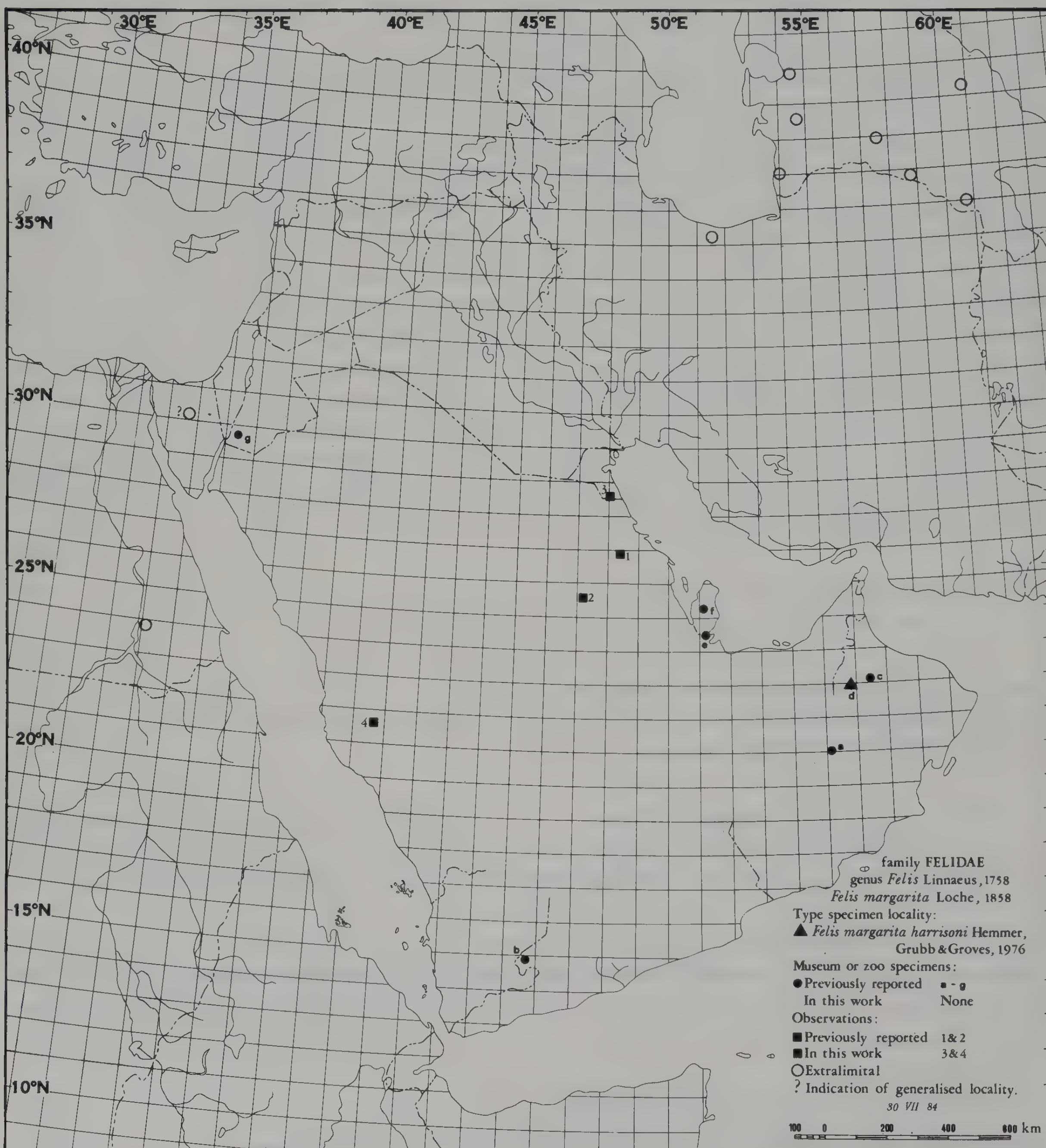



Fig. 17: Distribution map of sand cat.

### *Felis margarita margarita*

Diagnosis: size, small in both sexes, skull relatively narrow with relatively small bullae, small carnassials, low narrow occiput; high values of allometric exponents for breadth measurements/greatest length. Colour relatively bright; well marked, with buffy-white paws, buffy collar on throat, 2–6 tail rings. (HEMMER, GRUBB & GROVES 1976: 300).

### *Felis margarita harrisoni*

Diagnosis: males small, female (one skull only recorded by SCHAUENBERG, 1974) diminutive; skull broad with large bullae, high broad occiput, large carnassials. Colour more as nominate race with bright hue, well expressed pattern etc., but even more sharply marked: less extensive and diffuse darkening on dorsal surface, clean white paws with relatively sharp transition to buff of legs; five to seven tail rings in adults; but ear patch smaller, less dark. (HEMMER, GRUBB & GROVES 1976: 301).

Records and map designations (fig. 17, table 12):

Previously reported: a) THESIGER, 1948 p. 5 and HAYMAN & HARRISON, 1950 p. 418; b) HAYMAN, 1952 p. 99, HALTENORTH, 1953 p. 71 and HARRISON, 1968 pp. 288, 290; c) & 1. HARRISON, 1968 p. 288; d) HARRISON, 1968 p. 288 and HEMMER et al., 1976 p. 301; e) HARRISON, 1972 p. 628; f) SCHAUENBERG, 1974 p. 953; 2. VINCETT, 1982 p. 204; g) HEMMER, 1978 p. 62.

In this work: 3 – 1953, Wafra 28°33′N 48°02′E, 100 m, kitten captured photographed, colour slide in HZM archives (escaped from captivity), JG; 4 – 15.IX.1980 Ashayrah 21°39′N 40°38′E, 1340 m, live sand cat in sand dunes 8 p. m., WB.

## Genus *Caracal* Gray, 1843

Medium sized, long-limbed, short tailed cat with distinctive long (50 mm approx.) ear tufts. Pelage of uniform colour without spots or stripes.

Dental formula: i 3/3 c 1/1 pm 3/2 m 1/1 = 28.

### *Caracal caracal* (Schreber, 1776). **Caracal**

1776 *Felis caracal* Schreber: Säugeth.: 110, text *3:* 413, 587, 1777, Cape Town.

### *Caracal caracal schmitzi* (Matschie, 1912)

1895 *Felis caracal* Schreber; Yerbury & Thomas, Proc. Zool. Soc.: 548, Aden.
1900 *Felis caracal* Schreber; Thomas, Proc. Zool. Soc.: 100, Wadi el Kabir W of Lahej nr Aden (Percival Dodson).
1912 *Felis (Caracal) caracal schmitzi* Matschie: S. B. Ges. Nat. Fr. Berlin 64, nr Dead Sea, Palestine.
1939 *Caracal caracal* (Schreber); Morrison-Scott, Novit. Zool. Tring *41:* 197, Qaim nr Taif (Philby).
1968 *Caracal caracal schmitzi* (Matschie, 1912); Harrison *2:* 295.

Caracals are medium sized cats (TL 85–114 cm, T 23–32 cm, height at shoulders c. 45 cm, weight 8–14 kg), ground colour uniformly sandy or reddish sandy colour without pattern, black spots on either side of the muzzle and black vertical bars over the eyes. Long ear tufts (c. 50 mm) in well developed animals, the backs of the ears are black. The tail, relatively short, is of uniform colour without stripes or black tip. Legs are long and slender without elbow bars, ventral parts whitish (Plate 6).

The caracal's normal diet of about 1 kg per day, consists of small birds, mammals, reptiles and amphibians. Two or three (rarely 5) kittens in a litter are reared in the burrows of other animals or crevices, hollow trees or caves. The usual habitat is heavily vegetated areas, generally associated with water.

Plate 6: Caracal, at Al Rafia Farm Zoo, Jeddah, from "near Taif". 1984 (Photo J. Gasperetti).

The caracal is known from most of Africa, except the Sahara and the rain forests, across the Sinai and the Near East to Russian Turkestan, north to the Aral Sea, and east to northern India.

In Arabia, it is not common, but widespread. Reported from near Taif, near Khamis Mushayt and Wadi Khaytan, near Aden in South Yemen, Dhofar, Oman and the UAE.

Easily baited and trapped, their continued existence is precarious at best. Large and well managed protected areas need to be established to assure the long term survival of this rare animal.

Records and map designations (fig. 18, table 13):

Previously reported: 1. Yerbury & Thomas, 1895 p. 548; a) Thomas, 1900 p. 100; b) Morrison-Scott, 1939 p. 197; c), d), e) Harrison, 1968 p. 298; f) Barnes, 1983 p. 42; 2. Hills, 1979 p. 567; g) Nader, 1984 p. 148.

In this work: h – late 1974, Thamarit 17°38′N 54°01′E, skin HZM 4.8566, RH; 3 – 1975 Khamis Mushayt 18°18′N 42°44′E, 2000 m, live caracal in captivity Musallam Shaman's Zoo in King Faisal Military City "captured in this area" (MS), probably the same animal beautifully depicted in Vincett (1982 p. 202) without locality or comment, MS, JPG; 4 – 12.XII.1979 Wadi Runib 18°40′N 56°09′E, caracal killed DP(2) in litt. 23.IV.1980, MDG photograph noted DLH; i – UAE (died in Al Ain Zoo) skull ♂ HZM 6.11629, PD; 5 – 7.IX.1983 Al Rams 25°53′N 56°02′E, "strange beast caught in bathroom", photographs of caracal that entered a school, DLH, CF; j – 17.II.1983 Wadi Khaytan 19°45′N 41°40′E, 820 m, dead caracal hanging in tree, skull saved HZM 7.13196, JPG; k – recent capture of a caracal in a jump trap "near Taif" i. e. no locality, animal required amputation of right foreleg, while anesthesized by IGM, measured JPG. This caracal is now ensconced in the menagerie at the Al Rafia

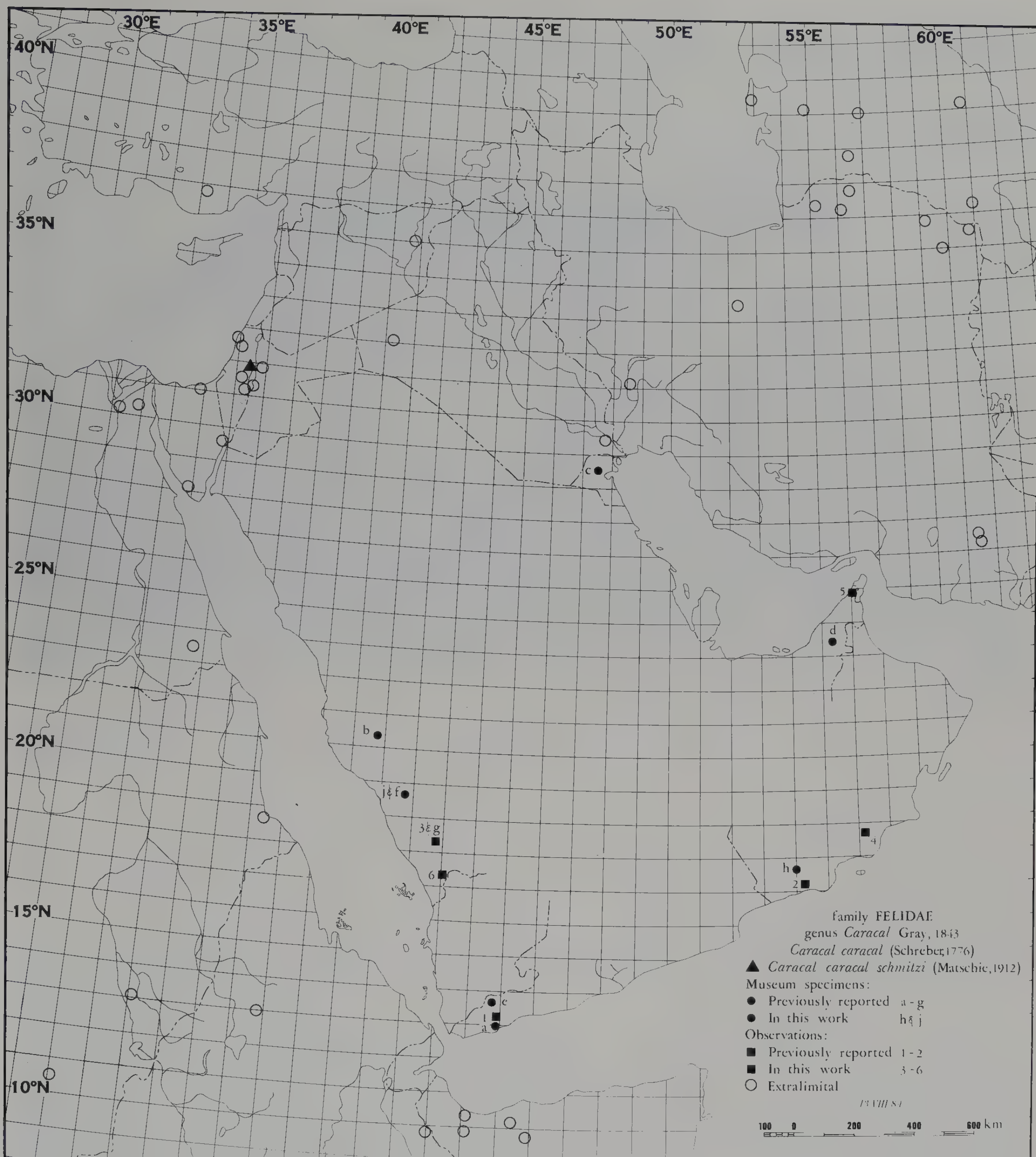



Fig. 18: Distribution map of caracal.

Farm nr Jeddah. 6 – 26.III.1983 btwn Malik & Abyam nr 17°16′N 43°03′E, photographs of dead caracal hanging in tree, WP.

## Genus ***Panthera,*** Oken, 1816

Large, powerful cats with certain distinctive anatomical features to separate them from *Felis* genetically, though some argument persists.

Dental formula: i 3/3 c 1/1 pm 3/2 m 1/1 = 30 (as in *Felis*).

***Panthera pardus*** (Linnaeus, 1758). **Leopard**

1758 *Felis pardus* Linnaeus: Syst. Nat. 10th Ed. *1:* 41, Egypt.

***Panthera pardus nimr*** (Hemprich & Ehrenberg, 1833)

1833 *Felis nimr* Hemprich & Ehrenberg: Symb. Phys. Mamm. *2:* gg, pl. 17, "In Syria, Arabiae Felicis montibus propre Gumfudam, in Dongola, aethiopiae et in Habessiniae littore a nobis observatis", restricted to mountains nr Qunfidah by Harrison, 1968: 302.

***Panthera pardus jarvisi*** Pocock, 1932

1932 *Panthera pardus jarvisi* Pocock: Abstr. Proc. Zool. Soc.: *33;* Proc. Zool. Soc.: 546, Sinai (Col. C. S. Jarvis).

***Panthera pardus tulliana*** (Valenciennes, 1856)

1856 *Felis tulliana* Valenciennes: C. R. Acad Sci. *42:* 1039, Ninfi 40 km E of Smyrna (Izmir, Turkey).

*P. p. jarvisi* and *P. p. tulliana* are not known in Arabia, the former is the race known in Sinai and the latter in Palestine. They could conceivably occur in the northwestern reaches of the peninsula. Only *P. p. nimr* has been authenticated in the country.

A large, powerfully built cat with short, stout legs (TL 160 – 259 cm, T 66–94 cm), unmistakably spotted with black rosettes on a variable ground colour usually of pale golden brown. Underparts and inner limbs less densely spotted. The ears are rounded, black posteriorly with distinct white center spot. Eyes with yellow iris and round pupils. Long tail tipped black without terminal tuft, reaches the ground when the animal is standing (Plate 7).

The leopard, in about 30 confused subspecies, is distributed in tropical Africa and in southern Asia from the Mediterranean north to Turkey, east to the Caspian Sea and across the southern periphery of Asia to Korea and Java. In Arabia, a distinct subspecies, *Panthera pardus nimr,* is recognized.

It was once no doubt more common in the montane periphery of western Arabia thence eastward across the southern part of the peninsula to Oman. At the time writing it is probably confined to southern Asir, Yemen, the remoter mountains of South Yemen and in the mountainous Ras Musandam in Oman, due to shooting and poisoning.

There appears to be a fallacy concerning the leopard's diet. Baboons *(Papio hamadryas)* are not the staple food. As an eminent world authority on primates, Prof. H. Kummer said, "it would, probably, in practical terms, be the other way around" (pers. comm., JG). Prof. Kummer added, "the baboons live in clans, bands and troops organized for survival. It is conceivable that a leopard would find a baboon strayed from its band or troop and would quickly kill and eat of it and escape. It is, of course, impossible that a leopard, or any other animal, could attack and eat a baboon when the baboon is in its own society. The large canine-toothed male baboons are formidable foes". Kummer (1971) notes that "the baboon's defense is not to hide from the predators, but to discover them. Having done so, with a massive attack the baboons discourage predators. If predation persists, band and troop sizes increase". The leopard, which requires on average about 3 kg of food each day for subsistence probably eats hyrax, hares, rodents, reptiles, and birds. There is no doubt that a hungry leopard may kill goats, sheep, donkeys, cows or horses. In the lush, verdant area of its present restricted habitat this is unlikely.

A leopard may eat an occasional goat or sheep, especially stray animals. Such stray animals, of course, are subject to predation by wolves, other wild cats, and lesser beasts of prey. As Kummer et al. (1981) points out, it appeared to him in his baboon survey that there is little or no predation whatsoever on baboons, and he notes "this is cause for concern about the survival of the local populations of wolf, leopard and striped hyaena".


Plate 7: Leopard *(Panthera pardus nimr)*. Reproduction of hand coloured drawing from HEMPRICH & EHRENBERG (1833, 2, pl. 17). Photograph taken from an original copy in Harrison Zoological Museum, Sevenoaks.

The leopard needs urgent protection if it is to be saved from extinction.

At the time of writing its extermination is imminent for several reasons. They are shot, poisoned and snared. Also, tracked to their lair, walled in with stones and cement and left to starve. The skins are usually sold in the suqs of towns in the Asir region for a paltry sum. Large and well managed protected areas are required to assure its survival.

The conservation of the Arabian leopard is of cardinal concern. Legislation in Saudi Arabia is being prepared to prohibit the trade in leopard skins and all other wildlife products mentioned in the CITES convention. Furthermore, it would be a worthy consideration to compensate herdsmen and farmers for animals lost to leopard predation.

Strict protection of the leopards should be enforced by training gamewardens to prevent shooting, trapping, baiting, poisoning and molesting this feline in its natural habitat.

Records and map designations (fig. 19, table 14):

Previously reported: a) HEMPRICH & EHRENBERG, 1833 2 gg- pl. 17; 1. BOTTA, 1841 p. 65; 2., 3. CARRUTHERS, 1909 p. 1135; 4. BURY, 1911 p. 287; 5. THOMAS, 1932 p. 44; 6. RASWAN*, 1935 p. 680; 7., 8.

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* RASWAN, who was a famous Arabist and travelled extensively in the Near East dealing in the trade of Arabian horses, tells a sad tale (1935 p. 68) of his nomad companions shooting a mother and two cubs. In his book there is no mention of the cheetah, yet the photograph in the book (p. 171) is a cheetah and not a leopard.

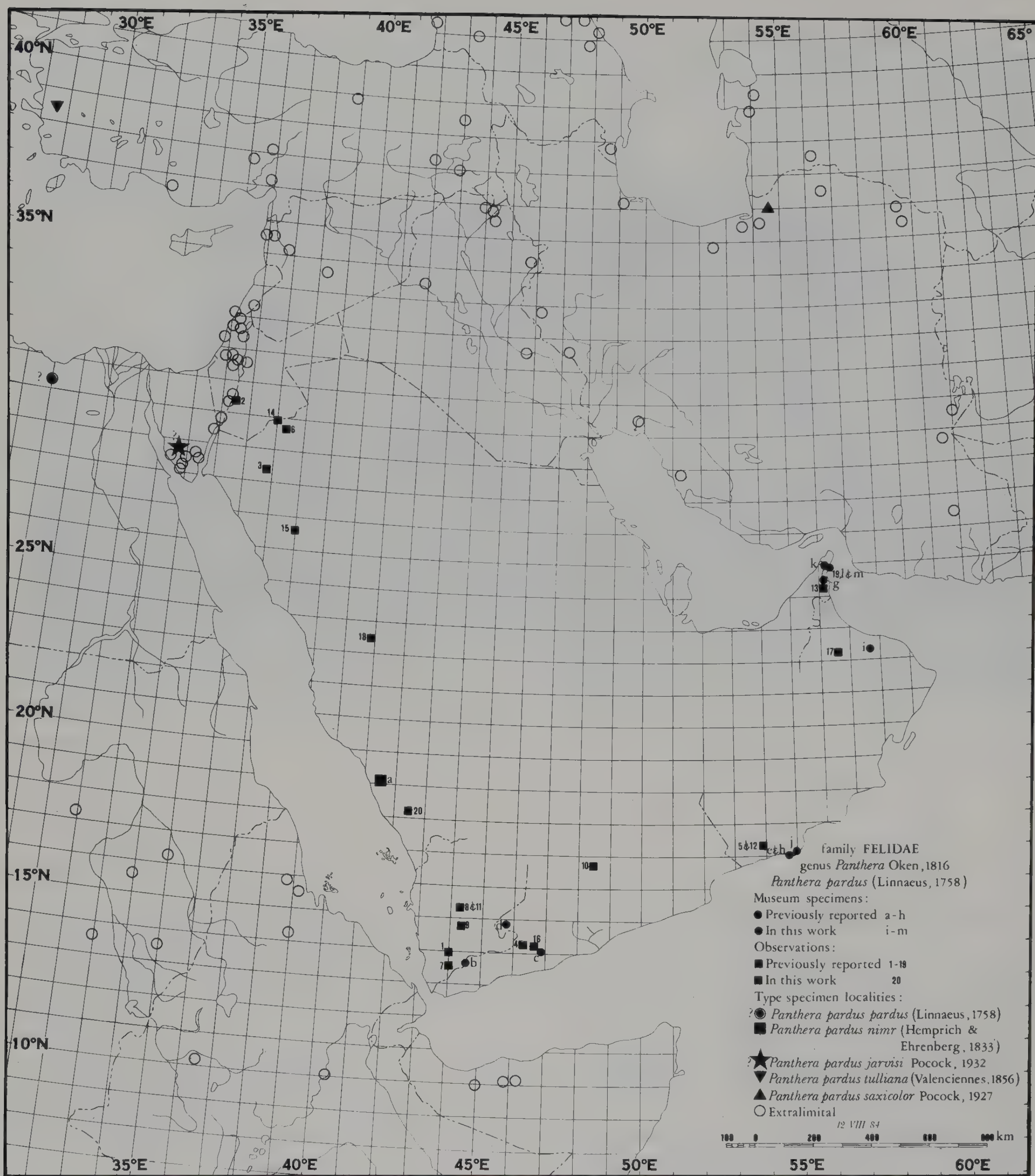


Fig. 19: Distribution map of leopard.

Scott, 1942 pp. 93, 132; 9., 11. Sanborn & Hoogstraal, 1953 p. 238; 10. Thesiger, 1949 p. 25 (Thesiger, 1946 p. 196 reports leopards in the Asir without locality); 12. Thesiger, 1959 p. 81; 13. Tyrell, 1963 p. 119; 14.–17. & b), c), d), e), f) Harrison, 1968 p. 307; g) Harrison, 1971 p. 116; 18. Harrison, 1972 p. 628; 19. Harrison, 1977 p. 20; h) Harrison, 1980 p. 392.

In this work: 20 – IV.1982 nr Wadi Hiswa 18°15′N 42°28′E, observation of a live leopard, AS (in litt.), JG; Note: skins with teeth, but no skulls in KSU-CE, Abha, and fine mounted specimen in lobby of Al Buhaira Hotel in Abha "killed in this area", but no localities and dates are known, JPG; HRH Sultan ibn Khalid ibn Faisal noted a dead specimen in the Gizan sukh summer of 1980 "probably from the area", pers. comm., WB; i – IX.–X.1976 Tawi Mahbayl 23°20′30″N 57°41′E, skull and part skin HZM 5.8749, DHI; j – XI.–XII.1977 Jebel Samhan 17°10′N 54°56′E, examined, DLH 10.VI.1978, TH; k – III.1979 Wadi Maqlayli 25°56′30″N 56°16′30″E, in ONM, RHT; l – VI.1980 nr Alama 25°57′N 56°27′E, skull large ♂, ONM, SG; m – 20.IX.1980 nr Lima 25°57′N 56°27′E, skull of ♀, ONM, SG.

### Genus *Acinonyx* Brookes, 1828

Large cats with long, thin limbs, with specialized hunting habit of pursuit and capture based on its tremendous speed. Solid black spots, tail ringed with black distally with white tip. Face marked with long black stripes from the eyes to the mouth.

Dental formula: i 3/3 c 1/1 pm 3/2 m 1/1 = 80.

***Acinonyx jubatus*** (Schreber, 1776). **Cheetah**

1776 *Felis jubata* Schreber: Säugeth. *3:* 1105 (1776) text, 392, 586 (1777), Cape of Good Hope.

***Acinonyx jubatus venaticus*** (Griffith, 1821)

1821 *Felis venatica* Griffith: Vert. Anim. Carnivora: *93,* India.

1937 *Acinonyx jubatus venaticus* Griffith; Pocock, Fauna Brit. India. Mamm. *1:* 325.

A long slender cat with thin long legs (TL 195 cm, T 69 cm) coat coarse and short, ground colour pale buff entirely covered with black spots except on the white belly. The tail is also spotted basally, the distal half is banded with a bushy white tip. The hairs on the neck and shoulders are more dense forming a slight wiry mane. In juveniles the mane is more pronounced. Rounded small head with black nose pad and black stripe from inner eye to corner of mouth. Eyes with amber iris and round pupil, ears short and rounded black posteriorly.

The cheetah is usually diurnal, in hotter weather it is crepuscular. It awaits its prey, usually birds, hares or gazelle, which it will capture with a tremendous burst of speed. Their food requirement is about 3 kg daily.

An animal of the open country it was once widespread in the semi-deserts and steppes over most of Africa and the Middle East to southern Russian Turkmenia, to central India and northern Deccan. In Arabia, the Cheetah probably was widespread, having been more widely distributed than is indicated in the records. It was, and is, no doubt more susceptible to human pressure as it is such a large animal and its habitat is the open country. It is hoped that in some corner of the vast deserts in Arabia the cheetah is still extant.

Corkill (1929 p. 701) noted that a cheetah had given birth to two cubs in an old well. These were captured in VII.1928, and one of them lived in the London Zoo where it died 5.VI.1932.

Records and map designations (fig. 20, table 15):

Previously reported: a) Corkill, 1929 p. 700, Pocock, 1946 p. 312 and Harrison, 1968 p. 311; 1. Carruthers, 1909 p. 1135; 2. Carruthers, 1935 p. 60; 3. Morrison-Scott, 1951 p. 2; 4. Dickson, 1971 p. 187; 5. Harrison, 1968 p. 310; 6. Harrison, 1972 p. 628; 7. Raswan, 1935 p. 68 (see p. 171); b) XI.–XII.1977 nr Jibjat 17°15′N 54°27′E, skin in TH Coll. (TL dry skin 1626), Harrison, 1983 p. 334.

In this work: None.

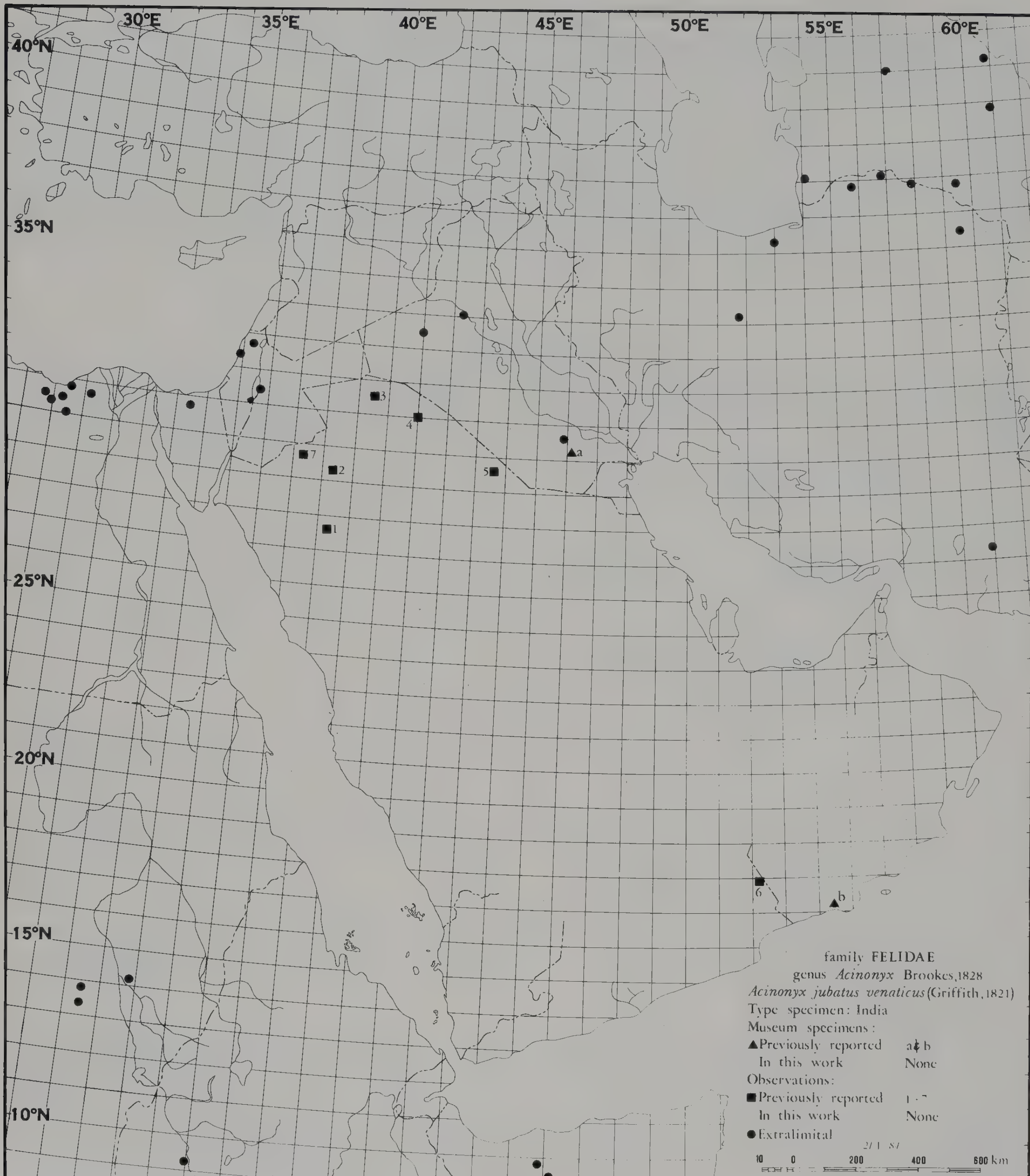


Fig. 20: Distribution map of cheetah.

## 4. ACKNOWLEDGEMENTS

Sincere thanks are due to the collectors and observers whose records were made available for this study. Their names are abbreviated in the text, but appear in the Table of Abbreviations. To each of them we express our appreciation. The information they supplied has broadened the knowledge of the status of the species reported.

We gratefully acknowledge the loan of colour slides and photographs and the permission to reproduce them in this publication; Mrs. S. Collenette, Jeddah, Pekke Luhas, c/o FAO, Rome, Dr. Carmi G. Penny, Director of San Diego Zoo, and Dr. H. Jungius, WWF/IUCN, Gland.

We are also indebted to Dr. B. C. R. Bertram, Curator of Mammals, Zoological Society, London, who advised the writers about the food requirements of the various species. His vast experience with predators in the field coupled with supervising their care in captivity establishes his authority on the subject.

The maps were compiled by the senior author. We express our gratitude to Billy Thompson, USGS, Denver, who assisted greatly with cartography of the base maps and to Mrs. Sue Kennedy, Jeddah, who did the final drafting.

Our thanks are due to Dr. Jacqueline Schonewald of the California Academy of Sciences and Gen Suwa, graduate student at the University of California at Berkeley, for measurements of specimens deposited at the CAS many years ago.

We sincerely thank Kathy Martin and Jennifer Jeffreys, Librarians at the British Museum (Natural History), London, whose untiring research assistance was invaluable, and Dr. H. Jungius, WWF/IUCN for suggestions in connection with conservation aspects.

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# 6. APPENDICES

## 6.1. Abbreviations

### Museums and collections:

| | |
|---|---|
| ADA | A. D. Al-Khalili Collection |
| ARF-J | Al Rafia Farm, Jeddah |
| BM(NH) | British Museum (Nat. Hist.), London |
| BZM | Berlin Zoological Museum |
| CAS | California Academy of Sciences, San Francisco |
| CNHM | Chicago Natural History Museum |
| HZM | Harrison Zoological Museum, Sevenoaks |
| IAN | Iyad Nader Collection |
| KSU-CE | King Saud University – College of Education, Abha |
| ONM | Oman National Museum, Muscat |
| SMF | Senckenberg Museum, Frankfurt |
| TH Coll | T. Henry Collection |
| ZMKSU-R | Zoological Museum, King Saud University, Riyadh |

### Other abbreviations:

| | |
|---|---|
| & | and |
| appr. | approximately |
| btwn | between |
| DOR | Dead on Road |
| imm | immature |
| inf | infant |
| juv | juvenile |
| m | meters above sea level |
| mi | mile |
| nr | near |
| NSL | Near sea level |
| rd | road |
| SubA | Sub-adult |
| w | with |
| yng Ad | Young adult |
| xing | crossing |

### List of persons supplying records:

| | |
|---|---|
| A | AA, A. D. Abbott; ADA, Abdulkadhim D. Al-Khalili. |
| B | AB, A. Berkeley; MSCB, M. St. C. Baddeley; DCB, David & Christine Barnes; JNB, J. N. Barnes; SB, S. Bihari; KB, Keith Brockie; CSB, C. Seton Browne; DBM, D. Bruce-Merrie; WB, W. Büttiker; JEB, J. E. Burchard; GB, G. Burkholder; DdB, D. de Bruin; |
| C | LC, Miss Laura Caliendo; ISC, Mrs. Sheila Collenette; |
| D | RHD, R. H. Daly; PD, P. Dickinson; |
| E | PE, P. Elsässer; KGE, K. Gotto Elsässer; |
| F | SKF, HRH Sultan ibn Khalid ibn Faisal al Saud; KF, K. P. Ferguson, Jr.; RAF, Robert A. Fraser; RBF, Robert B. Fraser; RNF, R. N. Fryer; CF, C. Furley; |
| G | MDG, M. D. Gallagher; JG, John Gasperetti: JPG, John & Patsy Gasperetti; PRG, Patsy Gasperetti; AG, A. Genadily; SG, Sandy Gordon; JEG, J. E. Grainger; AAG, A. Green; |

| | |
|---|---|
| H | MMH, Mel & Margaret Hanes; JNH, Justin & Nicky Harris; DLH, D. L. Harrison; SBH, Scott & Blanche Harrison; MH, Mrs. M. Harvey; TH, T. Henry; KH, Khushal Habibi; RH, R. Huntington; |
| I | DHI, D. H. Insall; PI, P. Irving; |
| J | MCJ, M. C. Jennings; PJ, Peter Jackson; |
| K | FK, Fayak Kattan; HAK, Hatim & Ingrid al Khalidi; BK, B. F. King; |
| L | TL, T. Larsen; JJL, John J. Lavranos; AL, A. Leaney; CLL, Chris & Lorraine Legg; CL, C. Legg; DL, Commander D. Lickfold; EDL, Mrs. Eloise Duffy Liddicoat; WKL, W. K. Liddicoat; WDL, W. K. & Duffy Liddicoat; RL, R. Linton; JLL, Jon & Jannie Lockhart; PL, Pekke Luhas; |
| M | JM, J. Mandaville; PDM, P. D. Manser; IGM, Ian G. McLaren; NM, N. McNiell; JAM, John A. McStay; PEM, P. E. Merrin; PM, P. Middleton; |
| N | IAN, Iyad Nader; AKN, Abdul Karim Nasher; SSN, Sami Saleh Nawar; MN, M. Nicholson; |
| P | DP(2), D. Pickerton; DP(1), D. Pitcher; PP, P. Priscott; RP, R. Priscott; RLP, Robin & Leila Priscott; SP, S. Priscott; WP, W. Peters; |
| R | SBR, Suwalim Barsak Rahbi; MGTR, M. G. T. Robb; |
| S | JBS, J. B. Sale; SG, Saudi Gazette, Jeddah; DS, Dr. Seay; RS, R. Semora; MS, Col. Musallim Shaman; ES, E. Sidorowics; JWS, John W. Smith; PS, P. Smith; AJS, A. J. Stagg; |
| T | RHT, R. H. Thompson; |
| W | FJW, F. J. Walker; DSW, David & Sue Waters; AW, A. Westby; PGW, P. Granville White; TW, T. Wilby; |
| Z | YAZ, Yusuf Abu Zaid. |

## 6.2 Taxonomic Tables

### Taxonomic criteria:

| | |
|---|---|
| TL | Total length: from tip of snout to tip of tail, fully extended, but not including pencil of hairs on tail. |
| T | Tail: from base of tail to tip not including pencil of hairs on tail. |
| HB | Head & body (snout to base of tail). |
| HF | Hind foot: from extremity of heel to the extremity of longest digit excluding claw. |
| FA | Forearm: from extremity of elbow to the tip of longest digit excluding claw. |
| E | Ear: from the lower border of the external meatus to the tip excluding any tuft of hair. |
| GtL | Greatest length of skull: greatest diameter anteroposteriorly of the skull. |
| CBL | Condylobasal length: from the exoccipital condyle to the anterior extremity of the premaxillary. |
| ZB | Zygomatic width: the greatest width of the skull across the zygomatic arches. |
| BB | Breadth of the braincase: the width of the braincase at the posterior roots of the zygomatic arches. |

| | |
|---|---|
| IC | Interorbital constriction: the narrowest width across the interorbital region. |
| PC | Postorbital constriction: the narrowest width behind the postorbital processes. |
| $CM^*$ | Maxillary toothrow: from the front of the upper canine to the back of the last upper molar. |
| $CM_*$ | Mandibular toothrow: from the front of the lower canine to the back of the last lower molars. |
| M | Mandible: from the condyle of the mandible to its most anterior projecting point. |
| TymB | Tympanic bulla: the greatest anterio-posterior length of the tympanic bulla. |

**Table 1: Jackal (*Canis aureus*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | Schwarz, 1926, p.46 | BZM 8327 | Aden | c.1895 | 12°50' | 45°03' | – | J. Menges; Type of *Canis hadramauticus* Noack; Schwarz assigned this specimen to *C. a. riparius* |
| b | Cheesman & Hinton, 1924, p. 355 | BM(NH)25.4.3.44 | Hufuf | 28.XII.1913 | 25°20' | 49°34' | – | In: "In Unknown Arabia" not in Ann. Mag. Nat. Hist. (9) *14:* 548, 1924 |
| c | Harrison, 1968, p. 198 | BM(NH) 2.11.22.6 | South Arabia | – | – | – | – | G. Wyman Bury |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_3$ | M | Remarks |
| a | BZM 8327 | ♂ | Ad | – | – | – | – | – | – | – | 143 | 88.8 | – | 28.3 | – | – | 109.5 | Harrison, 1968, p. 198 |
| b | BM(NH) 25.4.3.44 | ♀ | Ad | 989 | 236 | 753 | 147 | – | 76 | 151 | 143.8 | 84 | 50 | 25 | 63.6 | 71.9 | 104.6 | Harrison, 1968, p. 198 |
| c | BM(NH) 2.11.22.6 | – | – | – | – | – | 148.5 | – | 89 | – | – | – | – | – | – | – | – | Harrison, 1968, p. 198 |

**Table 2: Wolf (*Canis lupus*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | Noack, 1896, p. 356 | BZM 12467 | Hadramaut | – | 15°50’ | 48°60’ | – | J. Merges; Noack’s *C. hadramauticus* |
| j | Harrison, 1968, p. 203 | BM(NH) 39.895 | Kuwait | – | 29°30’ | 47°30’ | – | |
| m | Harrison, 1968, p. 203 | BM(NH) 48.367 | Buraida | 8.IV.1947 | 26°20’ | 43°59’ | – | D. Vesey-Fitzgerald |
| n | Harrison, 1968, p. 203 | HZM 1.3902 | Jebel Hafit | | 24°03’ | 55°46’ | | |
| o | Harrison, 1968, p. 203 | HZM 5.4416 | Nizwa | | 22°56’ | 57°33’ | | |
| s | Nader & Büttiker, 1980, p. 410 | IAN 586 | Km 11 Taif-Abha Rd. | 5.XI.1974 | 21°14’ | 40°30’ | 1,500 | J. Gasperetti & Michael Gill |
| t | Nader & Büttiker, 1980, p. 410 | IAN 681 | Hijla | 15.V.1977 | 18°15’ | 42°38’ | | Iyad Nader |
| r | Harrison, 1980, p. 392 | HZM 11.9114 | Salala-Thamarit Rd. | 22.IX.1977 | 17°17’ | 54°05’ | 750 | P. Granville White & J. B. Sale; Topotype |
| e | Dollman, 1932, p.339 | BM(NH) 34.8.4.12 | Ain, Qara Mts. | 9.XI.1934 | 17°15’ | 53°53’ | 762 | Bertram Thomas; type *C. l. arabs* Pocock, 1934, p. 636 |
| g | Pocock, 1935, p. 449 | BM(NH) 97.1.14.4 | Fuleij | 13.III.1914 | 23°42’ | 57°53’ | – | A. S. G. Jayakar |
| h | Morrison-Scott, 1939, p. 201 | BM(NH) 40.193 | 18 mi N of Jidda | 15.XII.1937 | 21°51’ | 39°07’ | 12 | A. G. Griffin |
| k | Harrison, 1968, p. 203 | BM(NH) 39.896 | Kuwait | – | 29°30’ | 47°30’ | – | |
| l | Harrison, 1968, p. 203 | BM(NH) 39.890 | Kuwait | – | 29°30’ | 47°30’ | – | |
| p | Harrison, 1968, p. 203 | HZM 2.3903 | Saham | – | 24°10’ | 56°53’ | – | |
| g | Harrison, 1968, p. 203 | HZM 7.4885 | Fizz | – | 24°30’ | 56°27’ | – | |
| b | De Winton, 1899, p. 536 | BM(NH) 95.10.8.1 | Aden | – | 12°50’ | 45°03’ | – | |
| d | Thomas, 1900, p. 101 | BM(NH) 99.11.6.36 | Lahej | 1899 | 13°01’ | 44°54’ | – | Percival & Dodson |
| f | Pocock, 1935, p. 449 | BM(NH) ? | Lahej | – | 13°01’ | 44°54’ | – | |
| f | Harrison, 1968, p. 203 | BM(NH) 24.8.13.1 | Lahej | – | 13°01’ | 44°54’ | – | Same animal noted by Pocock, above? |
| u | Nader & Büttiker, 1980, p. 410 | HZM 13.9597 | Wadi Khumra 60 km NW of Riyadh | 1977 | 24°55’ | 46°11’ | – | W. Büttiker |
| v | Nader & Büttiker, 1980, p. 410 | HZM 14.9598 | Wadi Khumra 60 km NW of Riyadh | 1977 | 24°55’ | 46°11’ | – | W. Büttiker |
| w | Nader & Büttiker, 1980, p. 410 | HZM 14.9599 | Wadi Khumra 60 km NW of Riyadh | 23.III.1978 | 24°55’ | 46°11’ | – | W. Büttiker |
| x | Nader & Büttiker, 1980, p. 410 | HZM 15.9600 | Wadi Khumra 60 km NW of Riyadh | 23.III.1978 | 24°55’ | 46°11’ | – | W. Büttiker |
| z | In this work | HZM 9.8336 | nr Dibbaa, Jebel Saatari | 29.XI.1976 | 25°39’ | 56°15’ | – | Suwalim Barsak Rahbi/D. H. Insall |
| aa | In this work | HZM 10.8748 | Qurayat | 18.IV.1977 | 25°39’ | 56°15’ | – | |
| bb | In this work | HZM 16.10685 | Wadi Shuqub | 1980 | 20°40’ | 41°15’ | | W. Büttiker |
| cc | In this work | HZM 17.11819 | km 121 Makkah by-pass | 16.II.1981 | 21°17’30” | 39°58’ | 305 | J. & P. Gasperetti |

**Table 2: Wolf (*Canis lupus*), continued**

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_3$ | M | Remarks |
| a | BZM 12467 | ♂ | Ad | – | – | – | – | – | – | – | 179 | 109 | – | 32.1 | 80.8 | – | 142 | SCHWARZ, 1926, p. 46 (*C. lupus* aff. *pallipes*) |
| j | BM(NH) 39.895 | ♂ | – | – | – | – | – | – | – | 220 | 206 | 130 | 65.8 | 44.2 | 93 | 103.4 | 164.7 | HARRISON, 1968, p. 203 |
| m | BM(NH) 48.367 | ♂ | – | 1140 | 320 | 820 | 197 | – | 80 | 208 | 190.2 | 107 | 61 | 35.8 | 87 | – | 155 | HARRISON, 1968, p. 203 |
| n | HZM 1.3902 | ♂ | – | – | – | – | – | – | – | 208 | 198 | 109 | 65.4 | 36.8 | 91.7 | – | – | HARRISON, 1968, p. 203 |
| o | HZM 5.4416 | ♂ | SubAd | – | – | – | – | – | – | 187 | 174 | 90.2 | 58.1 | 31.1 | 83.3 | – | 138.5 | HARRISON, 1968, p. 203 |
| s | IAN 586 | ♂ | YngAd | 1130 | 300 | 830 | 170 | – | 95 | 172 | 160 | 92.1 | 61.5 | 37.8 | 76.2 | 85.6 | 127.5 | TymB 19.6, NADER & BÜTTIKER, 1980, p. 410 |
| t | IAN 681 | ♂ | Ad | 1200 | 310 | 890 | 200 | – | 120 | 203 | 188 | 113.4 | 68.2 | 39.4 | 87.1 | 96.1 | 153 | TymB 24.1, NADER & BÜTTIKER, 1980, p. 410 |
| r | HZM 11.9114 | ♂ | Ad | 1400 | 450 | 950 | – | – | – | 210.9 | 200.3 | 110.3 | 64.4 | 36.3 | 89.9 | 99.3 | 159.5 | HARRISON, 1980, p. 392 |
| e | BM(NH) 34.8.4.12 | ♀ | – | – | – | – | – | – | – | 198.8 | 181.8 | 107.8 | 58.5 | 33.8 | 85.4 | 95.8 | 150.8 | HARRISON, 1968, p. 203 |
| g | BM(NH) 97.1.14.4 | ♀ | – | – | – | – | 184 | 324 | 92 | 192 | – | 106 | 59.2 | 35.5 | 84 | 96.8 | 148 | HARRISON, 1968, p. 203 |
| h | BM(NH) 40.193 | ♀ | Ad | – | – | – | – | – | – | 192 | 179.5 | 107 | – | 34 | – | – | – | MORRISON-SCOTT, 1939, p. 201 |
| k | BM(NH) 39.896 | ♀ | – | – | – | – | – | – | – | 201 | 188.9 | 115.5 | 63.2 | 36.6 | 86.6 | – | – | HARRISON, 1968, p. 203 |
| l | BM(NH) 46.890 | ♀ | – | – | – | – | – | – | – | 216 | 194 | 109 | 61.2 | 40.3 | 89 | – | – | HARRISON, 1968, p. 203 |
| p | HZM 2.3903 | ♀ | – | – | – | – | – | – | – | 189.9 | – | 101.3 | 58.6 | 35 | 82.3 | 88.8 | 141.8 | HARRISON, 1968, p. 203 |
| q | HZM 7.4885 | ♀ | – | – | – | – | – | – | – | 184.5 | 169 | 91.1 | 60.2 | 31.6 | 81.2 | 90.5 | 137.2 | HARRISON, 1968, p. 203 |
| b | BM(NH) 95.10.8.1 | – | – | – | – | – | – | – | – | 207 | 189 | 104.7 | 57.6 | 34.5 | 86 | 96.8 | 152 | HARRISON, 1968, p. 203 |
| d | BM(NH) 99.11.6.36 | – | – | – | – | – | – | – | – | 202 | 184 | 100 | 58 | 31.8 | 84.3 | 92.8 | 151.2 | HARRISON, 1968, p. 203 |
| f | BM(NH) ? | – | – | – | – | – | – | – | – | 200 | – | 100 | – | 37 | – | – | – | POCOCK, 1935, p. 449, probably BM(NH) 24.8.13.1, below |
| f | BM(NH) 24.8.13.1 | ♀ | – | – | – | – | – | – | – | 199 | – | – | – | 35.8 | 82.3 | – | – | HARRISON, 1968, p. 203 |
| u | HZM 12.9597 | – | – | – | – | – | – | – | – | 187.5 | 179.6 | 103.1 | 56.7 | 33.1 | 82.4 | – | – | TymB 24.7 D. L. Harrison |
| w | HZM 13.9598 | – | – | – | – | – | – | – | – | 217 | 203.7 | 112.8 | 64.3 | 36.1 | 93.3 | – | – | TymB 27.8 D. L. Harrison |
| w | HZM 14.9599 | – | – | – | – | – | – | – | – | 221 | 206.9 | 114.6 | 65.3 | 38.6 | 93.6 | – | – | TymB 29.7 D. L. Harrison |
| x | HZM 15.9600 | – | – | – | – | – | – | – | – | 198.3 | 197.3 | 113.1 | 63.7 | 40 | 91.4 | – | 159.2 | TymB 28.3 D. L. Harrison |
| z | HZM 9.8336 | – | Infant | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| aa | HZM 10.8748 | – | – | – | 348 | – | 140 | 70 | 120 | 208.1 | 190.3 | 106.8 | 66.4 | 38.9 | 87.5 | 98.1 | 157 | D. L. Harrison, this work |
| bb | HZM 16.10685 | – | – | – | – | – | – | – | – | 213.5 | 194.6 | – | 64.6 | 34.1 | 90.2 | – | 158.6 | D. L. Harrison, this work |
| cc | HZM 17.11819 | – | – | – | – | – | – | – | – | 186.9 | 178.3 | 97.3 | 57.7 | 33.4 | 81.3 | 92.5 | 139.4 | D. L. Harrison, this work |
| dd | HZM 18.13482 | – | – | – | – | – | – | – | – | 193.2 | 181.9 | – | – | 37.6 | 85.3 | – | 143.8 | D. L. Harrison, this work |

**Table 3: Fox (*Vulpes vulpes arabica*)**

| | | External Measurements | | | | | | Cranial Measurements | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | Category | TL | T | Body | HF | FA | Ear | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_3$ | M |
| Males | Number of Specimens | 5 | 5 | 5 | 7 | 1 | 6 | 22 | 21 | 20 | 21 | 22 | 22 | 20 | 19 |
| | Largest Measurement | 1,003 | 420 | 583 | 152 | – | 108 | 145 | 138.8 | 74.3 | 46.1 | 27.4 | 63.8 | 70.3 | 105.5 |
| | Least Measurement | 910 | 377 | 530 | 105 | – | 85 | 113.8 | 109.4 | 60.4 | 38.8 | 20.5 | 51.8 | 57 | 84.8 |
| | Average | 946 | 393 | 554 | 131 | 202 | 95 | 133 | 127 | 69.5 | 42 | 23.5 | 59 | 65.5 | 100 |
| Females | Number of Specimens | 14 | 14 | 14 | 12 | – | 13 | 17 | 16 | 18 | 20 | 20 | 19 | 18 | 18 |
| | Largest Measurement | 930 | 379 | 610 | 130 | – | 109 | 133.7 | 128.3 | 70 | 47 | 25 | 60.7 | 65.8 | 102.4 |
| | Least Measurement | 607 | 240 | 367 | 100 | – | 67 | 113.8 | 109.4 | 59.3 | 38.8 | 19.9 | 51.2 | 56.9 | 84.2 |
| | Average | 826 | 326 | 500 | 119 | – | 92 | 124 | 119 | 65.5 | 41 | 22 | 55 | 61 | 92.5 |
| Unsexed | Number of Specimens | 2 | 2 | 2 | 2 | – | 2 | 7 | 7 | 5 | 7 | 7 | 7 | 7 | 7 |
| | Largest Measurement | 734 | 314 | 420 | 115 | – | 84 | 130.1 | 124.5 | 67.7 | 41.8 | 24.3 | 59.1 | 65.3 | 97 |
| | Least Measurement | 665 | 279 | 386 | 115 | – | 84 | 117.2 | 112.1 | 64.2 | 39.9 | 21.3 | 55.5 | 60 | 88.4 |
| | Average | 700 | 454 | 403 | 115 | – | 84 | 126.5 | 120 | 66 | 41 | 22.5 | 57 | 63 | 94.5 |
| Composite average | Number of Specimens | 21 | 21 | 21 | 21 | 1 | 21 | 46 | 44 | 43 | 48 | 49 | 48 | 45 | 44 |
| | Largest Measurement | 1,003 | 420 | 610 | 152 | – | 108 | 145 | 138.8 | 74.3 | 47 | 27.4 | 63.8 | 70.3 | 105.5 |
| | Least Measurement | 607 | 240 | 367 | 100 | – | 67 | 113.8 | 109.4 | 59.3 | 38.8 | 19.9 | 51.2 | 56.9 | 84.2 |
| | Average | 843 | 339 | 504 | 123 | – | 92 | 129 | 123 | 67 | 41 | 23 | 57 | 63 | 96 |

**Table 4: Rüppell's sand fox (*Vulpes rueppelli sabaea*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| c | Dollman, 1933, p. 394 | BM(NH) 34.8.8.2 | Hibaka Qa'amiyat | 23.II.1932 | 19°15' | 50°20' | 366 | H. St. J. B. Philby; Pocock, 1935, p. 454 |
| g | Morrison-Scott, 1939, p. 201 | BM(NH) 40.190 | Riyadh | 5.II.1934 | 24°39' | 46°46' | – | H. St. J. B. Philby |
| e | Morrison-Scott, 1939, p. 201 | BM(NH) 40.191 | Khafs | 23.II.1935 | 25°20' | 46°30' | – | H. St. J. B. Philby |
| i | Lewis, Lewis & Harrison, 1965, p. 63 | HZM 1.3733 | 40 km W of Badanah | 27.XII.1962 | 30°58' | 40°38' | – | R. E. Lewis |
| h | Lewis, Lewis & Harrison, 1965, p. 63 | AUB V6488 | 40 km W of Rafha | 20.XII.1962 | 29°36' | 43°13' | – | R. E. Lewis |
| k | Harrison, 1968, p. 215 | BM(NH) 48.376 | Nafud as Sirr | 1.IV.1946 | 25°15' | 44°15' | – | |
| l | Harrison, 1968, p. 215 | BM(NH) 48.373 | 50 mi W of Jauf | 10.III.1947 | 29°49' | 39°03' | – | |
| m | Harrison, 1968, p. 215 | BM(NH) 52.1487 | Yadimah Well | 24.XII.1951 | 18°31' | 44°12' | 1,180 | |
| d | Dollman, 1933, p. 394 | BM(NH) 34.8.8.3 | Hibaka Qa'amiyat | 23.II.1932 | 19°15' | 50°20' | 366 | H. St. J. B. Philby; Pocock, 1935, p. 454 |
| j | Lewis, Lewis & Harrison, 1965, p. 63 | AUB V6513 | 40 km W of Badanah | 28.XII.1962 | 30°58' | 40°38' | – | R. E. Lewis |
| n | Harrison, 1968, p. 215 | BM(NH) 48.374 | 5 mi W of Jauf | – | 29°49' | 39°47' | – | |
| b | Dollman, 1933, p.394 | BM(NH) 34.8.8.4 | Ain Sala | 10.II.1932 | 19°56' | 51°03' | 198 | H. St. J. B. Philby; Pocock, 1935, p. 454 |
| p | In this work | HZM 3.10587 | Abu Dhabi-Oman border | VII.1977 | 24°20' | 55°45' | – | died in captivity XII.1979, P. Dickinson |
| a | Dollman, 1931, p. 227 | BM(NH) 34.8.4.11 | Rub al Khali lat 20°44' | 14–19.I.1931 | 20°45' | 51° | – | Bertram Thomas; Pocock, 1934, p. 636 type |
| f | Morrison-Scott, 1939, p. 201 | BM(NH) 40.192 | Alam Abyadh | – | 16°00' | 45°42' | – | H. St. J. B. Philby |
| o | Harrison, 1977, p. 19 | HZM 2.7308 | Jabal Ali | 7.X.1973 | 25°02' | 55°05' | NSL | M. D. Gallagher |
| q | In this work | HZM 4.12079 | Rub al Khali | 17.II.1982 | 20°16' | 49°42' | – | J. Mandaville |

**Table 4: Rüppell's sand fox (*Vulpes rueppelli sabaea*), continued**

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_3$ | M | Remarks |
| c | BM(NH) 34.8.8.2 | ♂ | Ad | 715 | 291 | 424 | 99 | – | 98 | 106.7 | 101 | 56.3 | 35.8 | 20.2 | 48.2 | 56.3 | 78.8 | Harrison, 1968, p. 215 |
| g | BM(NH) 40.190 | ♂ | Ad | 766 | 315 | 451 | 107 | – | 110 | 108.1 | 104.9 | 56.7 | 37.1 | 18.8 | 48.2 | 54.2 | 80.2 | Harrison, 1968, p. 215 |
| e | BM(NH) 40.191 | ♂ | Ad | 775 | 255 | 520 | 105 | – | 88 | 101.3 | 97.1 | 55.2 | 36 | 18.8 | 46.3 | 51.8 | 76 | Harrison, 1968, p. 215 |
| i | HZM 1.3733 | ♂ | | 737 | 296 | 441 | 112 | – | 98 | 106 | 102.5 | 55.9 | 36.1 | 20.3 | 46.8 | 51.9 | 79.1 | Harrison, 1968, p. 215 |
| h | AUB V6488 | ♂ | | 660 | 260 | 400 | 102 | – | 98 | 97.8 | – | 55.2 | – | 20.2 | 45 | 49.8 | 72.2 | Harrison, 1968, p. 215 |
| k | BM(NH) 48.376 | ♂ | Ad | 805 | 355 | 450 | 112 | – | 95 | – | – | – | – | – | – | – | – | Harrison, 1968, p. 215 |
| l | BM(NH) 48.373 | ♂ | Ad | 740 | 300 | 440 | 100 | – | 100 | 109.2 | 105.4 | 55 | 36 | 18.5 | 49.5 | 55 | 81 | Harrison, 1968, p. 215 |
| m | BM(NH) 52.1487 | ♂ | | 740 | 320 | 420 | 115 | – | 95 | – | – | – | – | – | – | – | – | Harrison, 1968, p. 215 |
| d | BM(NH) 34.8.8.3 | ♀ | Ad | 664 | 271 | 393 | 99 | – | 94 | 100.8 | 97 | 56.2 | 35.7 | 18.4 | 45.1 | 50.6 | 76 | Harrison, 1968, p. 215 |
| j | AUB V6513 | ♀ | Ad | 727 | 302 | 425 | 106 | – | 94 | 102.6 | – | 53.8 | – | 18.9 | 46.1 | 51.6 | 75.8 | Harrison, 1968, p. 215 |
| n | BM(NH) 48.374 | ♀ | | – | – | – | – | – | – | 105.7 | 102 | 53.8 | 36 | 19.2 | 48 | 53.2 | 78.6 | Harrison, 1968, p. 215 |
| b | BM(NH) 34.8.8.4 | ♀ | SubAd | 593 | 251 | 342 | 90 | – | 93 | 91.1 | 86.9 | 48.8 | 32.7 | 16.2 | 41 | – | 66.5 | Harrison, 1968, p. 215 |
| p | HZM 3.10587 | ♀ | Ad | 620 | 320 | 300 | 102 | 63 | – | 100.3 | 96.5 | 52 | 38.6 | 18.4 | 44.6 | 50.1 | 74.2 | D. L. Harrison |
| a | BM(NH) 34.8.4.11 | – | imm. | – | – | – | – | – | – | 97.7 | 93.6 | 51.8 | 34 | 17.2 | 44.3 | 49.7 | 72.3 | Harrison, 1968, p. 215 |
| f | BM(NH) 40.192 | – | – | – | – | – | – | – | – | 99 | 95.2 | – | 36.2 | 19.8 | – | – | 72.8 | Harrison, 1968, p. 215 |
| o | HZM 2.7308 | – | Ad | – | – | – | – | – | – | 109.2 | 103.5 | – | 40.3 | 20.6 | – | 52.4 | 79.0 | D. L. Harrison |
| q | HZM 4.12079 | – | Ad | – | – | – | – | – | – | 104.2 | 100.3 | – | 37.8 | 20.4 | 46.4 | 51.7 | 77.7 | D. L. Harrison |

**Table 5: Fennec (*Fennecus zerda*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | DOLLMAN, 1932, p.340<br>MORRISON-SCOTT, 1939, p. 199 | BM(NH) 25.8.4.1 | Kuwait | 21.VII.1935 | 29°30' | 47°30' | – | Dame Violet Dickson; presented to London Zoo, died in infancy |

| | | External Measurements | | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_3$ | M | Tym B. | Remarks |
| a | BM(NH) 25.8.4.1 | ♂ | imm | 583 | 215 | 368 | 96 | – | 97 | – | – | 44.2 | 32.6 | 15.7 | 34.7 | 38.2 | 58.8 | 21.2 | HARRISON, 1968, p. 218 |

**Table 6: Ratel or honey badger (*Mellivora capensis*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | Thomas, 1900, p.101 | BM(NH) 99.11.6.39 | Habil | IX.1899 | 13°01' | 44°54' | – | Percival & Dodson |
| f | Lewis & Atallah, 1966, p. 390 | AUB M989 | Badanah | 25.XI.1964 | 31°00' | 41°00' | – | C. Hardwick; intermediate *M. c. wilsoni* & *M. c. pumilio* |
| i | Harrison, 1968, p.247 | BM(NH) 54.1033 | Reidat as Seiar | – | 16°20' | 48°10' | – | |
| j | Harrison, 1968, p. 247 | HZM 2.4459 | Musaimir | – | 13°29' | 44°37' | – | |
| b | Thomas, 1900, p.101 | BM(NH) 99.11.6.40 | Habil | IX.1899 | 13°01' | 44°54' | – | Percival & Dodson |
| e | Pocock, 1946, p. 314 | BM(NH) 45.1 | Hadramaut | 28.VII.1933 | 15°50' | 48°50' | – | A. R. M. Richards; type *M. c. pumilio* died in London Zoo, 26.I.1945 |
| k | Harrison, 1968, p. 247 | BM(NH) 8.6.27.1 | South Arabia | – | – | – | – | |
| m | In this work | HZM 3.12055 | nr Thamarit | 1981 | 17°39' | 54°02' | – | J. N. Barnes/M. D. Gallagher; locality uncertain |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^1$ | $CM_1$ | M | Remarks |
| a | BM(NH) 99.11.6.39 | ♂ | | – | – | – | – | – | – | 125 | 123.6 | – | 50.2 | 32 | 37.2 | 42.3 | 82.1 | Harrison, 1968, p. 247 |
| f | AUB M989 | ♂ | | 788 | 246 | 542 | 108 | – | – | 126.2 | 123.8 | 72.3 | 59 | 33.6 | 36.3 | 42.2 | 83.8 | Harrison, 1968, p. 247 |
| i | BM(NH) 54.1033 | ♂ | | – | – | – | – | – | – | 121.2 | 119.7 | 64.6 | 50.2 | 30.3 | 35.4 | 39.2 | 78.7 | Harrison, 1968, p. 247 |
| j | HZM 2.4459 | ♂ | | – | – | – | – | – | – | 120.1 | 118.2 | 67.1 | 50 | 31.1 | 34 | 39.4 | 80 | Harrison, 1968, p. 247 |
| b | BM(NH) 99.11.6.40 | ♀ | | – | – | – | – | – | – | 121.9 | 120.6 | 71.8 | 52.7 | 32.6 | 36.2 | 40.3 | 78.1 | Harrison, 1968, p. 247 |
| e | BM(NH) 45.1 | ♀ | | – | – | – | – | – | – | 115.9 | 115 | 67.1 | 49 | 29.9 | 33.2 | 38.1 | 72.5 | Harrison, 1968, p. 247 |
| k | BM(NH) 8.6.27.1 | ♀ | | – | – | – | – | – | – | – | – | 58.5 | 47.3 | 25 | – | – | 65.8 | Harrison, 1968, p. 247 |
| m | HZM 3.12055 | – | Ad | – | – | – | – | – | – | 116.8 | 116.1 | – | 57.5 | 30.9 | 34.5 | 39.0 | 74.9 | D. L. Harrison, this work |

**Table 7: Indian grey mongoose (*Herpestes edwardsi*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | Morrison-Scott, 1939, p. 198 | BM(NH) 40.178 | Uqair | 22.VIII.1938 | 25°37' | 50°14' | NSL | H. St. J. B. Philby |
| b | Harrison, 1968, p. 266 | BM(NH) 47.1526 | Kuwait | 16.X.1945 | 29°20' | 47°59' | – | |
| e | Gallagher & Harrison, 1975, p.414 | HZM 3.5870 | Bahrain | 30.III.1970 | 26°00' | 50°30' | – | Mrs. C. Stroud |
| h | Al-Khalili, 1984, p.2 | ADA 703 | Jabalat Al Burhamah | 13.II.1984 | 26°13' | 50°33' | – | Abdul Kadhim D. Al-Khalili |
| c | Harrison, 1971, p.116 | HZM 1.5640 | Bahrain | 2.XI.1969 | 26°00' | 50°30' | – | C. Stroud/M. D. Gallagher |
| d | Harrison, 1972, p.628 | HZM 2.5824 | Sayhat | – | 26°29' | 50°03' | NSL | J. Mandaville |
| g | Nader, 1979, p.312 | IAN 675 | Al Qatif | – | 26°36' | 49°59' | NSL | Ali al Muallem |
| f | Gallagher & Harrison, 1975, p.414 | HZM 4.5895 | Malichiya | 14.VI.1970 | 26°06' | 50°29' | – | Mrs. C. Stroud |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_2$ | M | Remarks |
| a | BM(NH) 40.178 | ♂ | – | 739 | 371 | 368 | 69 | – | 18 | – | – | 36.1 | – | 14.8 | 27.8 | 31 | 47 | Harrison, 1968, p.266 |
| b | BM(NH) 47.1526 | ♂ | – | 711 | 305 | 406 | 70 | – | 12 | 77 ± | 76.8 ± | 38.3 | 27.8 | 14.2 | – | – | 47.3 | Harrison, 1968, p. 266 |
| e | HZM 3.5870 | ♂ | – | 754 | 354 | 400 | 71 | – | 25 | – | – | – | – | – | 27.9 | 30.9 | 49.2 | Gallagher & Harrison, 1975, p. 415 |
| h | ADA 703 | ♂ | – | 690 | 330 | 360 | 80 | – | 23 | – | – | – | – | – | – | – | – | Al-Khalili, 1984, p.2 |
| c | HZM 1.5640 | ♀ | – | 680 | 340 | 340 | 69 | – | 26 | 70 | 68.7 | 33.9 | 25.9 | 12.7 | 26.3 | 28.8 | 45.4 | Harrison, 1977, p. 116 |
| d | HZM 2.5824 | ♀ | imm. | 684 | 346 | 338 | 69 | – | – | 70.1 | 69.6 | 35 | 26.5 | 13.4 | 26.4 | 29.6 | 46.1 | Harrison, 1972, p. 628 |
| g | IAN 675 | ♀ | imm. | 495 | 234 | 261 | 61 | – | 18 | 57 | 56.8 | 29.5 | 25.2 | 16.5 | – | – | 34.2 | Nader, 1979, p. 312 |
| f | HZM 4.5895 | – | – | – | – | – | – | – | – | 72.3 | 70.6 | 35.7 | 26.3 | 13.2 | 26 | 29.6 | 46.8 | Gallagher & Harrison, 1975, p. 415 |

**Table 8: White-tailed mongoose (*Ichneumia albicauda albicauda*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | Thomas, 1894, p. 450 | BM(NH) 88.10.24.1 | Muscat | 1888 | 23°37' | 58°35' | – | A. S. G. Jayakar |
| c | Thomas, 1894, p. 450 | BM(NH) 89.4.2.1 | Muscat | 1889 | 23°37' | 58°35' | – | A. S. G. Jayakar |
| e | Thomas, 1894, p. 450 | BM(NH) 94.3.9.2 | Khode | 6.XI.1891 | 23°37' | 58°08' | – | A. S. G. Jayakar |
| i | Nader, 1979, p. 313 | IAN 658 | 10 km NE Abu Arish | 9.X.1975 | 17°02' | 42°55' | – | Killed by motorcyclist; I. A. Nader & J. Gasperetti |
| d | Thomas, 1894, p. 450 | BM(NH) 94.3.9.25 | Rui nr Muscat | 26.X.1891 | 23°37' | 58°35' | – | A. S. G. Jayakar |
| f | Harrison, 1968, p. 288 | HZM 1.4356 | Sohar | 11.I.1966 | 24°23' | 56°45' | – | |
| g | Nader et al., 1975, p. 231 | ZMKSU-R | Al Ardah | 21.III.1975 | 17°03' | 43°05' | – | A. R. al Shaer & Y. M. O. Faden & party |
| n | In this work | ARF-J | "near Taif" | V.1984 | – | – | – | locality unknown; collector unknown |
| j | Nader, 1979, p. 313 | SMF 40001 | Al Djadaijah, Ebb | 1971 | 14°00' | 44°15' | – | H. Peters |
| b | Thomas, 1894, p.450 | BM(NH) 88.10.24.2 | Muscat | 1888 | 23°37' | 58°35' | – | A. S. G. Jayakar |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_2$ | M | Remarks |
| a | BM(NH) 88.10.24.1 | ♂ | Ad | – | – | – | 105 | – | 34.5 | 91.3 | 88.3 | 44.1 | 33 | 17.2 | 35.8 | – | 62.4 | Harrison, 1968, p. 268 |
| c | BM(NH) 89.4.2.1 | ♂ | Ad | – | – | – | – | – | – | 92.6 | 89.9 | 43.3 | 32.2 | 17.8 | 35.3 | 39.8 | 63.3 | Harrison, 1968, p. 268 |
| e | BM(NH) 94.3.9.2 | ♂ | Ad | – | – | – | 100 | – | – | 96.6 | – | – | 34.2 | – | 36.2 | 40.1 | 64.2 | Harrison, 1968, p. 268 |
| i | IAN 658 | ♂ | SubAd | 840 | 390 | 450 | 110 | – | 40 | 88.3 | 87.6 | 43.3 | 31.7 | 19.1 | 34.5 | 38.1 | 61.4 | Nader, 1979, p. 313 |
| d | BM(NH) 94.3.9.25 | ♀ | imm | ±643 | ±312 | ±331 | 93.9 | 118 | 34 | – | – | – | – | – | – | – | – | Harrison, 1968, p. 268 |
| f | HZM 1.4356 | ♀ | Ad | 915 | ±256 | – | – | – | – | 92.5 | 92.1 | 48.7 | 32.4 | 19.1 | 36.7 | 40 | 66 | Harrison, 1968, p. 268 |
| g | ZMKSU-R | ♀ | Ad | 975 | 420 | 555 | 100 | 60 | 30 | – | – | – | – | – | – | – | – | I. A. Nader; mounted specimen |
| n | ARF-J | ♀ | YngAd | 788 | 356 | 432 | 96 | 122 | – | – | – | – | – | – | – | – | – | J. & P. Gasperetti w/I. McLaren |
| j | SMF 40001 | ♀? | Juv | 258 | 102 | 156 | 24 | – | – | – | 38.3 | – | – | – | – | – | – | D. Kock |
| b | BM(NH) 88.10.24.2 | – | Ad | – | – | – | 103 | – | 33.5 | 95 | – | 50.9 | 33.8 | 19.4 | 35.2 | – | – | Harrison, 1968, p. 268 |

**Table 9: Genet (*Genetta felina granti*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | Thomas, 1902, p. 487 | BM(NH) 22.11.22.3 | Azraki Ravine | 30.V.1902 | 13°22' | 44°39' | 1,586 | G. Wyman Bury; type |
| b | Thomas, 1902, p. 487 | BM(NH)22.11.22.4 | Azraki Ravine | – | 13°22' | 44°39' | 1,586 | G. Wyman Bury |
| g | Barnes, 1983, p. 39 | HZM 3.10942 | 30 km SE of Biljurshi | 11.VIII.1980 | 19°48' | 41°49' | 1,700 | J. & P. Gasperetti |
| c | Thomas, 1902, p. 487 | BM(NH) 22.11.23.1 | Azraki Ravine | – | 13°22' | 44°39' | 1,586 | G. Wyman Bury |
| f | Harrison, 1980, p. 391 | HZM 2.9117 | Khadrafi | 2.X.1977 | 16°41' | 53°09' | – | J. B. Sale |
| d | Harrison, 1968, p. 273 | BM(NH) 14.2.26.3 | Sok al Khamis | 19.VII.1913 | 15°08' | 43°56' | 2,134 | G. Wyman Bury |
| e | Nader, 1979, p. 315 | IAN 610 | 3 km S of Wadi Samra | 11.VI.1975 | 17°33' | 42°24' | ±50 | J. & P. Gasperetti w/D. de Bruin |
| h | In this work | ONM | Wadi Arbat | II.1979 | 17°06' | 54°08' | – | T. Henry (skin only) |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^2$ | $CM_2$ | M | Remarks |
| a | BM(NH) 2.11.22.3 | ♂ | – | 840 | 426 | 414 | 78 | – | 32 | 80.8 | 79.1 | 39.1 | 28 | 11.4 | 31.4 | 34.6 | 53.4 | Harrison, 1968, p. 273 |
| b | BM(NH) 2.11.22.4 | ♂ | – | 842 | 417 | 425 | 75 | – | 47 | – | – | – | – | 11.8 | 32.3 | 36.2 | 57 | Harrison, 1968, p. 273 |
| g | HZM 3.10942 | ♂ | – | 830 | 422 | 408 | 72.8 | 107.8 | 45.8 | – | – | – | – | – | 32.5 | 36 | 54.8 | D. L. Harrison |
| c | BM(NH) 2.11.23.1 | ♀ | – | – | – | – | 75 | – | 48 | – | – | – | – | – | – | – | – | Harrison, 1968, p. 273 |
| f | HZM 2.9117 | ♀ | – | 837 | 460 | 377 | 70 | – | 35 | 81.5 | 79.1 | 40 | 29 | 12.6 | 30.2 | 34.5 | 53.9 | Harrison, 1980, p. 391 |
| d | BM(NH) 14.2.26.3 | – | imm | 470 | 240 | 230 | 52 | – | 36 | 59.8 | – | – | – | 9.8 | – | – | – | Harrison, 1968, p. 273 |
| e | IAN 610 | – | – | 920 | 500 | 420 | 80 | – | 40 | – | – | – | – | – | 32.5 | 35.3 | 53.5 | Nader, 1979, p. 315 |
| h | ONM | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |

**Table 10: Striped hyaena (*Hyaena hyaena*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| d | Pocock, 1934, p. 814 | BM(NH) 34.8.4.7 | Ain, Qara Mts. | XI.1932 | 17°15' | 54°10' | – | Bertram Thomas |
| e | Pocock, 1934, p. 814 | BM(NH) 34.8.4.6 | Ain, Qara Mts. | XI.1932 | 17°15' | 54°10' | – | Bertram Thomas |
| p | In this work | CAS 9530 | Jabal Lidam | 1946 | 26°22' | 49°27' | 250 | J. Gasperetti |
| m | Nader & Büttiker, 1982, p. 507 | IAN 702 | nr Al Jurra | 20.XII.1977 | – | – | – | Iyad Nader; shot by Muhammed Maferrah |
| n | Nader & Büttiker, 1982, p. 507 | IAN 826 | nr Al Sirhan | 23.I.1981 | – | – | – | Iyad Nader; shot by shepherd |
| 37 | In this work | Not a specimen | Km 121 Makkah by-pass | 10.III.1983 | 21°17'30" | 39°58' | 305 | J. & P. Gasperetti |
| c | Pocock, 1934, p. 636 | BM(NH) 34.8.4.8 | Ain, Qara Mts. | XI.1932 | 17°15' | 54°10' | – | Bertram Thomas; type *H. h. sultana* |
| f | Harrison, 1968, p. 277 | BM(NH) 52.1483 | Ghail bin Yumaia | – | 15°35' | 49°31' | – | |
| l | Harrison, 1968, p. 277 | BM(NH) 2.11.22.5 | Azraki Ravine | – | 13°22' | 44°39' | – | G. Wyman Bury |
| r | In this work | HZM 5.10967 | 5 km NW Bani Sar | 14.VIII.1980 | 20°08' | 41°25' | 2,000 | Priscotts & Gasperettis |
| b | Thomas, 1900, p. 100 | BM(NH) 99.11.6.35 | Habil | 25.IX.1899 | 14°14' | 45°59' | – | Percival & Dodson |
| a | Harrison, 1968, p. 277 | BM(NH) 98.3.17.1 | Fileij | – | 23°43' | 57°53' | – | A. S. G. Jayakar |
| k | Harrison, 1968, p. 277 | HZM 1.2388 | Wadi Bana | – | 13°08' | 45°23' | – | |
| s | In this work | IAN 706 | Al Maski | – | – | – | – | Iyad Nader |
| t | In this work | IAN 772 | Al Sarhan | – | – | – | – | Iyad Nader |
| u | In this work | IAN 838 | Al Suda | – | 18°16' | 42°22' | 2,800 | Iyad Nader |
| q | In this work | HZM 4.9565 | Salalah-Thamarit Rd | – | 17°20' | 54°02' | – | Topotype |

**Table 10: Striped hyaena (*Hyaena hyaena*), continued**

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^1$ | $CM_1$ | M | Remarks |
| d | BM(NH) 34.8.4.7 | ♂ | Old | – | – | – | – | – | – | 242 | 210 | 150.2 | 68 | 42.2 | 89.1 | 95.4 | 161.9 | Harrison, 1968, p. 277 |
| e | BM(NH) 34.8.4.6 | ♂ | Ad | – | – | – | – | – | – | 225 | 206 | – | 63.3 | 37.8 | 83.9 | 91.7 | 161 | Harrison, 1968, p. 277 |
| p | CAS 9530 | ♂ | Ad | 1300 | 278 | 1022 | 190 | – | – | – | 196.5 | 141.5 | 57.5 | 43.5 | 81 | 89.5 | – | Skull meas., Gen. Suwa; tanned skin, J. Schonewald |
| m | IAN 702 | ♂ | SubAd | 1230 | 450 | 780 | 190 | – | 150 | 208 | – | 130 | 72 | 35 | 81 | 89 | 146 | Iyad Nader |
| n | IAN 826 | ♂ | Imm | 1300 | 280 | 1020 | 160 | – | 125 | – | – | – | – | – | – | – | – | Iyad Nader |
| 37 | Specimen lost | ♂ | Ad | – | – | 1040 | 190 | – | 140 | – | – | – | – | – | – | – | – | field meas., dead animal (taken by others) |
| c | BM(NH) 34.8.4.8 | ♀ | Ad | – | – | – | – | – | – | 220 | 202 | 143.7 | 63.7 | 41 | 84.1 | 92.3 | 158 | Harrison, 1968, p. 277 |
| f | BM(NH) 52.1483 | ♀ | – | – | – | – | – | – | – | 225 | 201 | 137.9 | 65.9 | 49.1 | 83.1 | 93.1 | 158.6 | Harrison, 1968, p. 277 |
| l | BM(NH) 2.11.22.5 | ♀ | imm | – | – | – | – | – | – | 216 | – | 126.7 | 64.3 | 43.1 | 81 | 90.1 | 152.7 | Harrison, 1968, p. 277 |
| r | HZM 5.10967 | ♀ | Ad | – | – | 1000 | 200 | 285 | 147 | 222.3 | 206.4 | 138.7 | 65.3 | 44.9 | 85.7 | 92.1 | 159 | D. L. Harrison |
| b | BM(NH) 99.11.6.35 | – | imm | – | – | – | – | – | – | 193 | 182 | 110.8 | 59.1 | 35.7 | 81.1 | – | – | Harrison, 1968, p. 277 |
| a | BM(NH) 98.3.17.1 | – | imm | – | – | – | – | – | – | – | – | – | 57.5 | 33.9 | 76.1 | – | – | Harrison, 1968, p. 277 |
| k | HZM 1.2388 | – | imm | – | – | – | – | – | – | 209.2 | 192.5 | 120 | 64 | 39.5 | 84.2 | 90.2 | 150.5 | Harrison, 1968, p. 277 |
| s | IAN 706 | – | Ad | – | – | – | – | – | – | 222 | 209 | 146 | 73 | 33 | 84 | 93 | 154 | I. A. Nader |
| t | IAN 772 | – | Ad | – | – | – | – | – | – | 225 | 209 | 144 | 69 | 37 | 84 | 92 | 155 | I. A. Nader |
| u | IAN 838 | – | Ad | – | – | – | – | – | – | 220 | 206 | 135 | 76 | 36 | 83 | 93 | 160 | I. A. Nader |
| q | HZM 4.9565 | – | Ad | – | – | – | – | – | – | 221.7 | 204.5 | 134.8 | 64.4 | 43.5 | 83.8 | 92.5 | 157.9 | D. L. Harrison |

**Table 11: Wild cat (*Felis silvestris*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | Yerbury & Thomas, 1895, p. 147 | BM(NH) 95.6.1.61 | Aden | 18.II.1895 | 12°50' | 45°03' | – | J. W. Yerbury; "*F. maniculata* Rüpp." |
| c | Cheesman, 1920, p. 331 | BM(NH) 20.1.19.2 | Koweit | 22.VI.1913 | 29°30' | 47°30' | – | W. H. Shakespeare; type of *F. ocreata iraki* |
| e | Morrison-Scott, 1939, p. 197 | BM(NH) 40.175 | Iraq Well | 6.XI.1936 | 17°40' | 44°00' | 1,311 | H. St. J. B. Philby; Pocock, 1951, p. 116 |
| i | Harrison, 1968, p. 284 | HZM 5.4535 | Suwera | 29.III.1967 | 24°19' | 56°49' | – | |
| k | Harrison, 1968, p. 284 | HZM 7.4537 | Wadi Suwera | 19.III.1967 | 24°18' | 56°46' | – | |
| l | Harrison, 1968, p. 284 | HZM 8.4539 | 5 mi SW of Sohar | 8.III.1967 | 24°17' | 56°42' | – | |
| n | Harrison, 1971, p. 117 | HZM 11.5755 | Dubai | 11.I.1970 | 25°14' | 55°17' | – | D. Ledger/M. D. Gallagher; *F. s. tristrami* |
| b | Thomas, 1900, p. 100 | BM(NH) 99.11.6.33 | Lahej | 27.VIII.1899 | 13°01' | 44°54' | – | Percival & Dodson; "*F. maniculata* Cretzsch" |
| f | Morrison-Scott, 1939, p. 197 | BM(NH) 40.176 | 15 mi N of Jidda | 7.I.1938 | 21°43' | 39°12' | NSL | H. St. J. B. Philby; Pocock, 1951, p. 116 |
| g | Morrison-Scott, 1939, p. 197 | BM(NH) 40.177 | 15 mi NE of Jidda | 10.X.1934 | 21°38' | 39°23' | NSL | H. St. J. B. Philby; Pocock, 1951, p. 116 |
| h | Harrison, 1968, p. 283 | HZM 6.4536 | 6 mi W of Sohar, Wadi Suwera | 25.III.1967 | 24°23' | 56°39' | – | Capt. A. French-Blake; type, *F. s. gordoni* |
| j | Harrison, 1968, p. 284 | HZM 4.4524 | 5 mi SW of Sohar | 24.II.1967 | 24°17' | 56°42' | – | |
| r | In this work | HZM 24.14197 | km 88 Makkah by-pass | 6.I.1984 | 21°14' | 39°47' | 250 | J. & P. Gasperetti |
| d | Dollman, 1933, p. 394 | BM(NH) 40.177a | Umm al Qurun | 1932 | 19°12' | 51°05' | – | H. St. J. B. Philby; Pocock, 1935, p. 455 & 1951, p. 116 |
| p | In this work | HZM 20.12017 | 40 km SE Biljurshi | 26.XI.1981 | 19°49' | 41°51' | 1,900 | J. & P. Gasperetti |
| q | In this work | HZM 23.13276 | km 50 Makkah-Taif Rd | 25.III.1983 | 21°21'30" | 40°14' | 880 | J. & P. Gasperetti |
| s | In this work | HZM 22.13032 | nr Bay'ah | | 25°39' | 56°16' | | probably large *Felis catus* |

**Table 11: Wild cat (*Felis silvestris*), continued**

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^1$ | $CM_1$ | M | Remarks |
| a | BM(NH) 95.6.1.61 | ♂ | Ad | – | – | – | – | – | – | 96 | 89 | 73 | 42 | 19 | – | – | 66 | Pocock, 1951, p. 22 *Felis catus* |
| c | BM(NH) 20.1.19.2 | ♂ | Ad | 1002* | 372* | 630* | 134* | – | 47* | 93.3 | 84.2 | 64.5* | 45±* | 16.1 | 29.6 | 32.2 | 60.7 | * Cheesman, 1920, p. 331; Harrison, 1968, p.284 |
| e | BM(NH) 40.175 | ♂ | Ad | 888* | 390 | 498* | 131* | – | 56* | 98.2 | 90 | 68.8 | 45.8 | 18.9 | 31.2 | 34.3 | 65 | * Morrison-Scott, 1939, p. 197; Harrison, 1968, p.284 |
| i | HZM 5.4535 | ♂ | – | 846 | 316 | 530 | 124.2 | 183 | 66.8 | 99 | 90.7 | 70.2 | 42.6 | 16.2 | 31 | 34.3 | 64.4 | Harrison, 1968, p. 284 |
| k | HZM 7. 4537 | ♂ | – | 743 | 291 | 452 | 115 | 173.5 | 64.8 | 81.4 | 76.8 | 57.4 | 40.7 | 14.4 | 27.5 | 30 | 54 | Harrison, 1968, p. 284 |
| l | HZM 8.4539 | ♂ | – | 813 | – | – | – | – | – | 90.3 | 82.2 | 61.6 | 41 | 15.7 | 28.9 | 32.4 | 58.7 | Harrison, 1968, p. 284 |
| n | HZM 11.5755 | ♂ | Ad | 780 | 310 | 470 | 125 | 180 | 55 | 103.8 | 94 | 74.3 | 44.3 | 19.7 | 30.9 | 34.7 | 71.5 | Harrison, 1971, p. 117 |
| b | BM(NH) 99.11.6.33 | ♀ | Ad | 770 | 290 | 480 | 120 | – | 57 | 89* | 82* | 64* | 42* | 17* | – | – | 60* | *Pocock, 1951, p. 22; Harrison, 1968, p. 284 |
| f | BM(NH) 40.176 | ♀ | – | – | – | – | – | – | – | – | – | 60.4 | 42.7 | 15.2 | 27.8 | 30.4 | 58.7 | Harrison, 1968, p. 284 |
| g | BM(NH) 40.177 | ♀ | imm | – | – | – | – | – | – | 82.7 | 73.8 | 52.7 | 40 | 14.1 | 28 | 29.6 | 55.1 | Harrison, 1968, p. 284 |
| h | HZM 6.4536 | ♀ | – | 669 | 263 | 406 | 110.2 | 164 | 67 | 81 | 73.1 | 56.3 | 39.6 | 13.6 | 26.7 | 28.7 | 52.9 | Harrison, 1968, p. 284 |
| j | HZM 4.4524 | ♀ | – | 787 | – | – | – | – | – | 80.5 | 74.1 | – | 39.7 | 15.9 | 26.4 | 28.7 | 54.1 | Harrison, 1968, p. 284 |
| r | HZM 24.14197 | ♀ | Yng | 725* | 305* | 420* | 112* | 66* | 68* | – | – | – | – | – | 26.7 | 29.6 | 54.1 | * Gasperetti; D. L. Harrison |
| d | BM(NH) 40.177a | – | – | – | – | – | – | – | – | 92.4 | 84.1 | 58* | 47* | 15.9 | 29.4 | 32.7 | 60.2 | * Pocock, 1951, p. 116; Harrison, 1968, p. 284 |
| p | HZM 20.12017 | – | Ad | – | – | – | 111.8 | – | 59.5 | – | – | – | – | – | – | 31.5 | – | D. L. Harrison |
| q | HZM 23.13276 | – | – | 920 | 390 | 530 | – | – | 65 | – | – | – | – | – | – | 32.1 | 57.8 | D. L. Harrison |
| s | HZM 22.13032 | – | Ad | – | – | – | – | – | – | 103.4 | 92.9 | 73.8 | 45.5 | 20.8 | 31.9 | 35.2 | 66.5 | D. L. Harrison |

**Table 12: Sand cat (*Felis margarita harrisoni*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| b | HAYMAN, 1952, p. 99; HALTENORTH, 1953, p. 71 | BM(NH) 59.634 | nr Beihan | 25.IV.1952 | 14°52' | 45°45' | – | A. H. Marsack, sent to London Zoo, 1952, died 19.X.1959 |
| d | HARRISON, 1968, p. 290 | HZM 2.4747 | Umm as Sanim | 2.VII.1967 | 21°55' | 55°50' | | P. A. Smith; type of *F. m. harrisoni* |
| e | HARRISON, 1972, p. 628 | HZM 3.5868 | Qatar/Abu Dhabi frontier | 28.II.1970 | 24°30' | 51°20' | | M. D. Gallagher |
| f | SCHAUENBERG, 1974, p. 953 | – | Qatar | 27.XII.1971 | 25°15' | 51°15' | | H.-E. Qassim Bin Hamad Al-Thani |
| g | HEMMER, 1978, p. 63 | | Wadi Ram | III./IV.1977 | 29°38' | 35°24' | | |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^1$ | $CM_1$ | M | Remarks |
| b | BM(NH) 59.634 | ♂ | Ad | 702 | 250 | 452 | 110 | – | 68 | 89.8 | 85.2 | 74.2 | 43.8 | 18.6 | 28 | 30.2 | 61 | TymB 24.1; HARRISON, 1968, p. 290 |
| d | HZM 2.4747 | ♂ | Ad | 730 | 260 | 470 | 110 | – | 65 | 90.3 | 84 | 71.6 | 44.5 | 19.5 | 28.3 | 30.4 | 60.9 | TymB 25; HARRISON, 1968, p. 290 |
| e | HZM 3.5868 | ♂ | Ad | 740 | 300 | 440 | 110 | 155 | 57 | 86.5 | 80.4 | 66 | 44.8 | 18.4 | 27.7 | 30.1 | 56.3 | TymB 24.9; HARRISON, 1972, p. 628 |
| f | – | ♀ | SubAd | 645 | 235 | 410 | 100 | – | – | 76.5* | – | – | – | – | – | – | – | * HEMMER, GRUBB & GROVES, 1976, p. 294 |
| g | | | | | | | | | | c.83 | 77–78 | 72–73 | 43 | | | | | HEMMER, 1978, p. 63 |

**Table 13: Caracal (*Caracal caracal schmitzi*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| k | In this work | ARF-J | Saudi Arabia | V.1984 | – | – | – | caught in jump trap, leg amputated |
| a | THOMAS, 1900, p. 100 | BM(NH) 99.11.6.34 | Habil, W of Lahej | 26.IX.1899 | 13°04' | 44°50' | – | Percival & Dodson |
| i | In this work | HZM 6.11629 | unknown (UAE) | – | – | – | – | died in Al-Ain Zoo; P. Dickenson |
| b | MORRISON-SCOTT, 1939, p. 197 | BM(NH) 40.174 | Qaim, nr Taif | 7.IX.1934 | 21°20' | 40°45' | 1,585 | H. St. J. B. Philby |
| c | HARRISON, 1968, p. 298 | BM(NH) 47.1549a | Kuwait | 10.VI.1939 | 29°30' | 47°30' | – | |
| f | BARNES, 1983, p. 42 | HZM 8.13444 | Wadi Khaytan | 28.V.1983 | 19°45' | 41°40' | 820 | D. & C. Barnes |
| d | HARRISON, 1968, p. 298 | HZM 1.4351 | nr Tawi Suwaikhan | – | 24°26' | 55°16' | – | |
| h | In this work | HZM 4.8566 | Thamarit | 1974 | 17°38' | 54°01' | – | R. Huntingdon, skin only |
| j | In this work | HZM 7.13196 | Wadi Khaytan | 17.II.1983 | 19°45' | 41°40' | 820 | J. & P. Gasperetti |
| g | NADER, 1984, p. 148 | IAN 812 | Abha District | 10.II.1980 | – | – | – | |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^1$ | $CM_1$ | M | Remarks |
| k | ARF-J | ♂ | YngAd | 904 | 273 | 631 | 172 | 262 | 82 | – | – | – | – | – | – | – | – | Ear tuft 50 mm J. & P. Gasperetti & I. McLaren |
| a | BM(NH) 99.11.6.34 | ♂ | – | – | – | – | – | – | – | 110.5 | 100.8 | 74 | 50.8 | 19.2 | 36.5 | 39.8 | 74.6 | HARRISON, 1968, p. 298 |
| i | HZM 6.11629 | ♂ | Ad | 1070 | 285 | 785 | 185 | – | 70 | 136.4 | 121.5 | 95.8 | 56.3 | 25.6 | 42 | 45.3 | 91 | HARRISON, in this work |
| b | BM(NH) 40.174 | ♀ | SubAd | 857* | 227* | 630* | 157* | – | 74* | 110.3 | 101 | 75.8 | 49.1 | 19.3 | 34.4 | 37.8 | 74.2 | * MORRISON-SCOTT, 1939, p. 197; HARRISON, 1968, p. 298 |
| c | BM(NH) 47.1549a | ♀ | imm | 546 | 152 | 394 | 101.5 | – | 63.5 | – | – | – | – | – | – | – | – | HARRISON, 1968, p. 298 |
| f | HZM 8.13444 | ♀ | imm | – | – | – | – | – | – | 124.6 | 114.8 | 85.5 | 53.7 | 24.2 | – | 43.3 | – | HARRISON, in this work |
| d | HZM 1.4351 | – | – | – | – | – | – | – | – | 129.1 | – | 89.5 | 55.4 | 24.8 | 40.8 | 42.9 | 88.4 | HARRISON, 1968, p. 298 |
| h | HZM 4.8566 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| j | HZM 7.13196 | – | Ad | – | – | – | – | – | – | 128.7 | 114.2 | 90.4 | 56.5 | 24.5 | 40.4 | 45 | 87 | HARRISON, in this work |
| g | IAN 812 | – | – | 800 | 100 | 700 | 130 | – | 15 (?) sic | 120 | 106 | 83.5 | 53 | 23.3 | 36.5 | 39.2 | 79 | I. A. Nader |

**Table 14: Leopard (*Panthera pardus nimr*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| g | Harrison, 1971, p. 116 | HZM 3.5057 | nr Qalidda Pass | – | 25°32’ | 56°08’ | – | R. J. G. Whitelaw |
| b | Harrison, 1968, p. 307 | HZM 1.3943 | Jebel Hasha | end XII.1963 | 13°43’ | 44°32’ | – | M. Crouch |
| c | Harrison, 1968, p. 307 | HZM 2.4233 | Mahfid | – | 14°04’ | 46°55’ | – | M. Crouch |
| d | Harrison, 1968, p. 307 | BM(NH) 55.428 | W of Beihan | 19.IV.1955 | 14°52’ | 45°45’ | – | |
| e | Harrison, 1968, p. 307 | BM(NH) 48.312 | Jebel Samhan | 1947 | 17°00’ | 54°45’ | – | |
| f | Harrison, 1968, p. 307 | BM(NH) 49.513 | Dhofar | – | – | – | – | |
| h | Harrison, 1980, p. 392 | HZM 6.9124 | Jebel Samhan | – | 17°00’ | 54°45’ | – | M G. T. Robb |
| i | In this work | HZM 5.8749 | Tawi Mahbayl | – | 23°20’30” | 57°41’ | – | D. H. Insall |
| k | In this work | ONM | Wadi Maglayli | III.1979 | 25°56’30” | 56°16’30” | – | R. H. Thompson |
| l | In this work | ONM | nr Alama, Lima Area | VI.1980 | 25°57’ | 56°27’ | – | S. Gordon |
| m | In this work | ONM | nr Lima | 20.IX.1980 | 25°57’ | 56°27’ | – | S. Gordon |

| | | External Measurements | | | | | | | | Cranial Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^1$ | $CM_1$ | M | Remarks |
| g | HZM 3.5057 | ♂ | Ad | 1665 | 814 | 851 | – | – | – | 196 | 182 | 119.7 | 74 | 39.5 | 65.9 | 72.3 | 131.2 | Harrison, 1971, p. 116 |
| b | HZM 1.3943 | – | – | 1676 | 660 | 1016 | – | – | – | – | – | – | – | – | – | – | – | Harrison, 1968, p. 307 |
| c | HZM 2.4233 | – | – | 1600 | 660 | 940 | – | – | 44 | – | – | – | – | – | – | – | – | Harrison, 1968, p. 307 |
| d | BM(NH) 55.428 | ♀ | Ad | 1778 | 737 | 1041 | – | – | – | 166.3 | 150.7 | 105.3 | 67.1 | 32.2 | 53.8 | 59.2 | 110.8 | Harrison, 1968, p. 307 |
| e | BM(NH) 48.312 | – | – | 1965 | 787 | 1178 | – | – | – | – | – | – | – | – | – | – | – | Harrison, 1968, p. 307 |
| f | BM(NH) 49.513 | – | – | 2007 | 813 | 1194 | – | – | – | – | – | – | – | – | – | – | – | Harrison, 1968, p. 307 |
| h | HZM 6.9124 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | D. L. Harrison |
| i | HZM 5.8749 | – | – | – | – | – | – | – | – | 208 | 190.3 | 129 | 76.8 | 43 | 64.8 | 74.9 | 140.8 | D. L. Harrison |
| k | ONM | – | – | – | – | – | – | – | – | – | – | 124.6 | – | 43.8 | 64.2 | 71.5 | 136.9 | D. L.Harrison |
| l | ONM | ♂ | – | – | – | – | – | – | – | 213 | 194.4 | 132.4 | 76 | 45.2 | 65.4 | 74.4 | 141.9 | D. L. Harrison |
| m | ONM | ♀ | – | – | – | – | – | – | – | 180.7 | 166.1 | 109.3 | 69.9 | 35.7 | – | 65 | 120.4 | D. L. Harrison |

**Table 15: Cheetah (*Acinonyx jubatus venaticus*)**

| MAP No. | Previously reported | Catalogue or Register No. | Locality | Date | N lat | E long | Elev | Remarks |
|---|---|---|---|---|---|---|---|---|
| a | CORKILL, 1929, p. 700; POCOCK, 1946, p. 312 | BM(NH) 43.56 | Busaiyah Wells | VII.1928 | 30°15' | 46°07' | – | presented to London Zoo 12.III.1930; died 5.VI.1932 |
| b | HARRISON, 1983, p. 334 | T. H. Coll. | nr Jibjat | XI./XII.1977 | 17°15' | 54°27' | – | skin; T. Henry |

| | | | | External Measurements | | | | | | Cranial Measurements | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP No. | Catalogue or Register No. | Sex | Age | TL | T | HB | HF | FA | EAR | GtL | CBL | ZB | BB | IC | $CM^1$ | $CM_1$ | M | Remarks |
| a | BM(NH) 43.56 | ♂ | Ad | – | – | – | – | – | – | 172* | 156.3 | 114.1 | 67.3 | 40.3 | 53.2 | 59.1 | 119.6 | HARRISON, 1968, p. 311, * = approx. |
| b | TH. Coll. | – | – | 1626 | – | – | – | – | – | – | – | – | – | – | – | – | – | dry skin; HARRISON, 1983, p. 334 |

بسم الله الرحمن الرحيم

إِنَّا كُلَّ شَيْءٍ خَلَقْنَٰهُ بِقَدَرٍ

صدق الله العظيم

# مقدمة

الدكتور عبد البر عبدالله القين
نائب رئيس عام مصلحة الارصاد وحماية البيئة

هذا هو المجلد السابع في سلسلة (المجموعة الحيوانية في المملكة العربية السعودية) التي برزت الى الوجود نتيجة جهد متفان بذله رهط من علماء حماية البيئة داخل المملكة وخارجها ، ونحن نأمل ان تستمر هذه الجهود وتبقى لأطول فترة ممكنة .

ويسعدني القول ان هذا المجهود الاساسي المتمثل في متابعة اصدار سلسلة (المجموعة الحيوانية في المملكة العربية السعودية) قد تطور تطورا واضحا تنوعا وكما ليكون وبحق احد المراجع الاساسية للمعلومات المتعلقة بحماية البيئة في العديد من المجالات في المملكة .

وتأتي المساهمات التي بذلت وتبذل لدراسة وتوثيق الحياة الحيوانية في المملكة متزامنة مع التخطيط لاقامة محميات برية وبحرية لعدد من البيئات المتميزة والفريدة في المملكة .

ونتيجة للمسوحات التي اجريت على الحياة الحيوانية خلال الاحد عشر عاما الماضية فقد توفر قدرا "كبيرا" من المعلومات المتعلقة بأنواع الحيوانات النادرة والمهددة بالانقراض ، اضافة الى البحوث العلمية في مجالي التصنيف والبيئة . كل ذلك مهد الطريق للتخطيط لاقامة محميات طبيعية في مناطق متنوعة التضاريس : من المناطق الرملية الجافة ، الى الصحارى الصخرية ، الى الجبال المنخفضة وشديدة الارتفاع الى المناطق الساحلية ، لتغطي بذلك أغلب انواع المواطن الاحيائية الطبيعية المتميزة بحياة نباتية وحيوانية فريدة .

والاحظ بكثير من الارتياح التقدم المستمر في مسوح الحياة الحيوانية والتي تساهم فعالة في ما تتضمنه هذه المجموعة اذ تحظى باهتمام متزايد على المستويات الوطني والاقليمي والدولي .

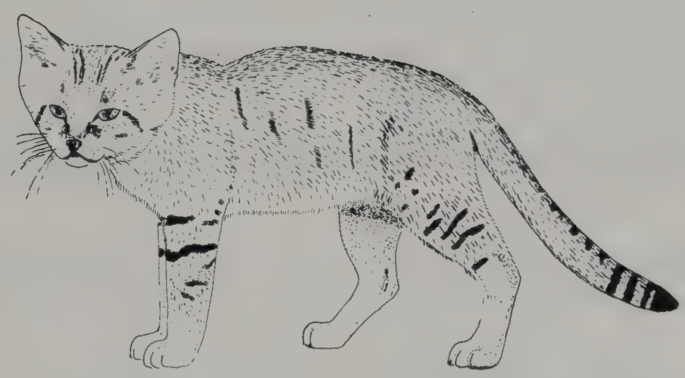
ولا شك أن هذا المجلد يعتبر أيضا مصدرا لغبطة وسرور كل الذين أسهموا في هذه السلسلة ، واولئك المهتمين بمجال حماية وصون الطبيعة . وفوق ذلك يعد دليلا صادقا على الاهتمام المتزايد بحماية البيئة لدى صانعي القرار والمواطنين عامة .

# اللجنة الاستشارية

| | |
|---|---|
| دكتور عبدالبر عبد الله القين | نائب الرئيس العام لمصلحة الارصاد وحماية البيئة (ميبا) ، جده |
| دكتور عبد الاله عبدالعزيز باناجه | استاذ مشارك في كلية العلوم بجامعة الملك عبدالعزيز بجده والمدير التنفيذي للهيئة الاقليمية للمحافظة على بيئة البحر الاحمر وخليج عدن . |
| دكتور مصطفى علي الدغيثر | مدير عام الادارة العامة لحماية البيئة (ميبا) جده . |
| الاستاذ عبدالوهاب محمد جميل دقاق | مدير ادارة الموارد الطبيعية (ميبا) جده |
| الاستاذ الدكتور نزار ابراهيم توفيق | مدير عام المركز الوطني للارصاد والبيئة (ميبا) جده |
| الاستاذ عبدالعزيز حمد المدبل | وكيل وزارة الزراعة والمياه الرياض |
| الاستاذ الدكتور محمد سعيد القحطاني | مدير جامعة الملك فيصل |
| دكتور اياد عبدالوهاب نادر | استاذ بكلية التربية فرع ابها |
| الاستاذ الدكتور عبدالمنعم تلحون | وزارة الزراعة والمياه الرياض |
| دكتور ميشيل برانكوشي | رئيس قسم الحشرات بمتحف التاريخ الطبيعي بازل - سويسرا |
| دكتور ولتر فيتمر | مشارك في سلسلة الحيوان بالمملكة العربية السعودية ، متحف التاريخ الطبيعي بازل سويسرا (متقاعد) |

# المجموعة الحيوانية
## في
## المملكة العربية السعودية

المجلد السابع



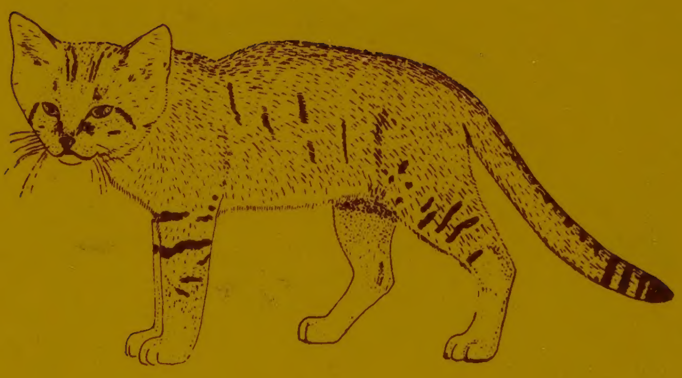
المملكة العربية السعودية
وزارة الدفاع والطيران
مصلحة الارصاد وحماية البيئة
مطبوعات المجموعة الحيوانية رقم ٧

إعداد

البروفيسور و. بوتيكر الدكتور ف. كروب

# المجموعة الحيوانية
## في
## المملكة العربية السعودية

### المجلد السابع



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إعداد

البروفيسور و. بوتيكر الدكتور ف. كروب